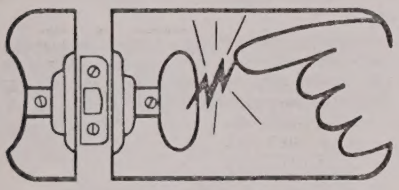
static awareness

A Message From

John Fluke Mfg. Co., Inc.

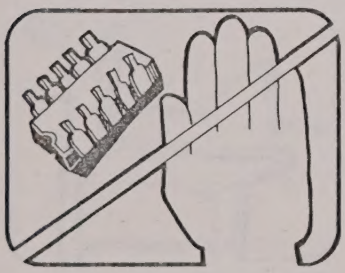


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

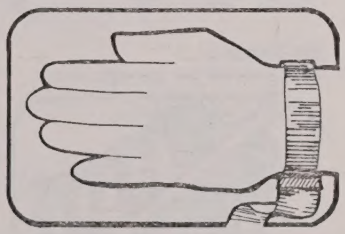
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗"

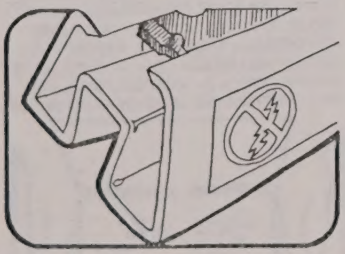
The following practices should be followed to minimize damage to S.S. devices.



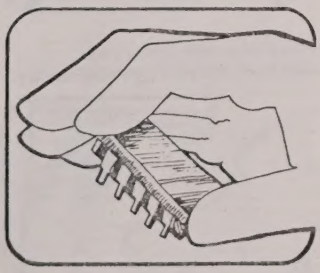
1. MINIMIZE HANDLING



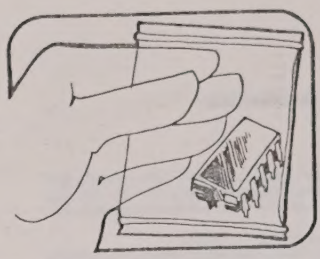
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



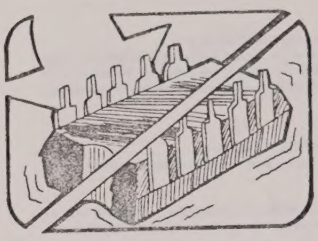
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



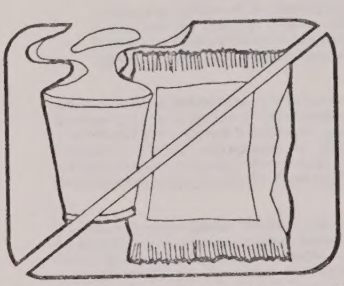
4. HANDLE S.S. DEVICES BY THE BODY



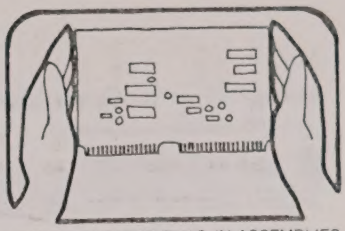
5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



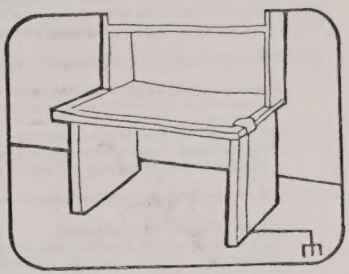
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR USUALLY PROVIDES COMPLETE PROTECTION TO INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Description
453522	6" X 8" Bag
453530	8" X 12" Bag
453548	16" X 24" Bag
454025	12" X 15" Bag
Pink Poly Sheet 30"x60"x60 Mil P/N RC-AS-1200 $20.00	Wrist Strap P/N TL6-60 $7.00

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AND GENERAL DYNAMICS, POMONA DIV.

* Dow Chemical

J00898-07U7810/SE EN Litho in U.S.A.

WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

The JOHN FLUKE MFG. CO., INC., warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 1 year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90 days), or any product or parts which have been subject to misuse, neglect, accident, or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within 1 year of the original purchase, provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 1 year of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. JOHN FLUKE MFG. CO., INC., SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

If any failure occurs, the following steps should be taken:

1. Notify the JOHN FLUKE MFG. CO., INC., or nearest Service facility, giving full details of the difficulty, and include the model number, type number, and serial number. On receipt of this information, service data, or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of JOHN FLUKE MFG. CO., INC., instruments should be made via United Parcel Service or "Best Way"* prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The JOHN FLUKE MFG. CO., INC, will be happy to answer all applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 5053, 5004 EB Tilburg, The Netherlands.

*For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206

Rev. 6-81

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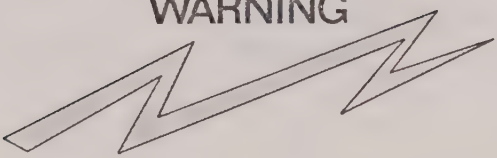
WARNING



HIGH VOLTAGE

is used in the operation of this equipment

DEATH ON CONTACT

may result if personnel fail to observe safety precautions

Never work on the instrument unless there is another person nearby who is familiar with the operation and hazards of the equipment and who is competent in administering first aid. When the technician is aided by operators, he must warn them about dangerous areas.

Whenever possible, the power supply to the equipment must be shut off before beginning work on the equipment. Take particular care to ground every capacitor likely to hold a dangerous potential. When working inside the equipment, after the power has been turned off, always ground every part before touching it.

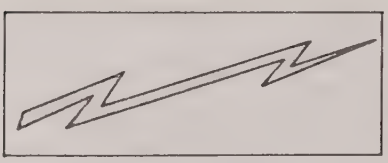
Be careful not to contact high-voltage connections for the line power ac input connections when installing or operating this equipment.

Whenever the nature of the operation permits, keep one hand away from the equipment to reduce the hazard of current flowing through vital organs of the body.

Greater than 500 volts exist in the following assemblies

POWER SUPPLY
PREAMPLIFIER
POWER AMPLIFIER
OUTPUT TERMINALS

Warning: **Potentials less than 500 volts may cause death under certain conditions; Therefore, reasonable precautions should be taken at all times!**



FIRST AID FOR ELECTRIC SHOCK

RESCUE

FREE VICTIM FROM CONTACT WITH LIVE CONDUCTOR QUICKLY. AVOID CONTACT WITH EITHER LIVE CONDUCTOR OR VICTIM'S BODY.

Shut off high voltage at once and ground circuit. If high voltage cannot be turned off quickly, ground circuit.

An ax with a dry wooden handle may be used to cut high voltage line. Use extreme caution to avoid resulting electric flash.

If circuit cannot be broken or grounded, use a dry board, dry clothing, or other nonconductor to free victim.

SYMPTOMS

NEVER ACCEPT ORDINARY AND GENERAL TESTS FOR DEATH.

Symptoms of electric shock may include unconsciousness, failure to breathe, absense of pulse, pallor, and stiffness, as well as severe burns. WHENEVER VICTIM IS NOT BREATHING PROPERLY, GIVE ARTIFICIAL RESPIRATION

TREATMENT

START ARTIFICIAL RESPIRATION IMMEDIATELY.

Perform artificial respiration at scene of accident, unless victim's or operator's life is endangered. IN THIS CASE ONLY, remove victim to safe location nearby. If new location is more than a few feet away, give artificial respiration while victim is being moved.

After starting artificial respiration, continue without loss of rhythm for at least FOUR HOURS, or until victim is breathing without help. If you have to change operators while giving artificial respiration, do so without losing rhythm of respiration.

AFTER VICTIM REVIVES

Be prepared to resume artificial respiration, as he may stop breathing again.

When victim is COMPLETELY CONSCIOUS, give him a stimulant (NOT AN ALCOHOLIC DRINK) such as a teaspoonful of aromatic spirits of ammonia in a small glass of water, hot coffee, or hot tea.

Keep victim warm and lying down until he has been conscious for at least fifteen minutes.

POSITION VICTIM

Place victim in face-upward position and kneel close to his ear.

CLEAR THROAT

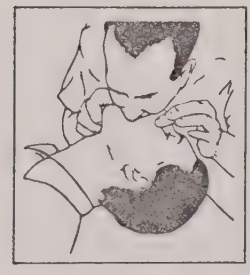
Turn head to one side and quickly wipe out any fluid, mucus, or foreign body from mouth and throat with fingers.

OPEN AIR PASSAGE

Tilt head back and extend neck to open air passage.

LIFT JAW FORWARD

Place thumb in victim's mouth and grasp jaw firmly. Lift jaw forward to pull tongue out of air passage. Do not attempt to hold or depress tongue.



PINCH NOSTRILS CLOSED

With other hand pinch nostrils closed to prevent air leak.

FORM TIGHT SEAL WITH LIPS

Rescuer's wide-open mouth completely surrounds and seals open mouth of victim. This is not a kissing or puckered position -- mouth of rescuer must be wide-open.

BLOW

Exhale firmly into victim's mouth until chest is seen to lift. This can be seen by rescuer without difficulty.

REMOVE MOUTH AND INHALE

During this time, rescuer can hear and feel escape for air from lungs. Readjust position if air does not flow freely in and out of victim's lungs.

Continue at a rate of 12 to 20 times per minute.

Breathing should be normal in rate with only moderate increase in volume, so that rescue breathing can be continued for long periods without fatigue. Do not breathe too forcibly or too large a volume if victim is an infant or small child.

Section 1

Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 5215A Precision Power Amplifier is a dc coupled, broad band inverting amplifier with a set gain of 100. The 5215A is used in combination with the 5200A AC Calibrator for a combined output ranging from 100 (100.000) to 1100 (1100.000) volts rms at frequencies up to 100 kHz.

1-3. Connection of the Model 5200A AC Calibrator with the supplied factory cable provides all the analog signal and remote programming data required.

1-4. The amplifier output cable is installed on the front panel. It may be installed on the rear panel for system operations if desired as Option —07. The standard output cable is a permanently attached, three foot long, four wire, low capacitance cable which allows remote sensing, high output current and high frequency operation.

1-5. Equipment protection is provided by the Fault and the Overload circuits. Activating the fault circuit automatically reverts the unit to the Standby mode and removes any voltage present from the output. Faults can originate from procedural errors or equipment failure. A fault due to procedural error can be removed by resetting the systems and performing the restarting procedure. An overload error can be corrected by removing the overload from the circuit. Return to operate will occur automatically when the overload is removed, unless the overload is accompanied by a fault. In this case, power must be removed and restored to remove the indications.

1-6. SPECIFICATIONS

These specifications apply when using the 5200A on the 1000 volt range with the 5215A and its supplied interface cable. Refer to the 5200A data sheet for other voltage ranges, frequency accuracies and slew rates.

OUTPUT VOLTAGE
100V to 1099.999V rms

FREQUENCY RANGE
10 Hz to 100 kHz (120 kHz typical)

RESOLUTION
1 mV

AMPLITUDE ACCURACY
(For 90 day, 23°C±5°C, after 1 hour warmup)
(Maximum Load — zero to full load)

1000V Range	(X% of setting + Y% of Range)
10 Hz to 30 Hz	(0.12 + 0.005)
30 Hz to 20 kHz	(0.04 + 0.002)
20 kHz to 50 kHz	(0.08 + 0.005)
50 kHz to 100 kHz	(0.10 + 0.01)

AMPLITUDE LIMITS WITH TEMPERATURE
(0°C to 18°C and 28°C to 50°C)

Add±(0.035 X Accuracy) per °C to the stated accuracy limits.

SHORT TERM AMPLITUDE STABILITY
The random charge in rms value will be less than (0.0007% of setting +0.0005% of range) p-p for the 1 kHz thru 100 kHz ranges and 0.005% p-p of range for the 100 Hz range over a 10 minute interval with constant line, load and temperature using an rms responding meter. (Fluke 931B or equivalent.)

LONG TERM AMPLITUDE STATILITY
(At Constant Line, Load and Temperature)

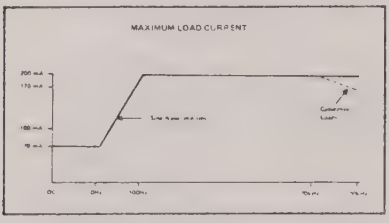
	24 Hours	Six Months
10 Hz to 20 kHz	0.01% of setting	0.02% of setting
20 kHz to 100 kHz	0.02% of setting	0.04% of setting

MAXIMUM CAPACITIVE LOAD
1500 pF (Not to exceed rated Load Current)
(170 mA allows 270 pF at 1000V 100 kHz)

OVERLOAD PROTECTION
Overload Limit protects against input noise spikes and momentary output overloads.

Overload Trip protects against input overdrive conditions, steady state output overloads and short circuits.

MAXIMUM LOAD CURRENT



DC OFFSET VOLTAGE
(For 90 days, 23°C±5°C, after 1 hour warmup)
±10 mV at the output

DC OFFSET VOLTAGE LIMITS WITH TEMPERATURE
(0°C to 18°C and 28°C to 50°C)
±1.0 mV °C at the output

TOTAL HARMONIC DISTORTION
(Bandwidth 10 Hz to 1 MHz)

(Resistive loads greater than 1.5k ohm or Capacitive loads less than 1000 pF)

10 Hz to 10 kHz ..... (0.05% of setting)
20 kHz to 50 kHz ..... (0.07% of setting)
50 kHz to 100 kHz ..... (0.1% of setting)

(Resistive loads less than 1.5 k ohm or Capacitive loads greater than 1000 pF)

10 Hz to 10 kHz ..... (0.05% of setting)
10 kHz to 20 kHz ..... (0.1% of setting)
20 kHz to 50 kHz ..... (0.17% of setting)
50 kHz to 100 kHz ..... (0.25% of setting)

RANDOM NOISE
(1 MHz bandwidth)
Less than 100 mV rms

LINE RELATED NOISE
Less than 50 mV rms

LINE REGULATION
±0.001% of setting for 10% change in line voltage.

INPUT POWER
100, 115, 200, 230V ac ±10%, internal jumper selected, 50 to 60 Hz. Receptacle on rear panel for 5200A input power

INPUT LINE CURRENT
The United States National Electrical Code requires that the two lines cords on the 5215A, under full load conditions, be connected to a 20A rated branch circuit with 15A rated receptacles. For international use, refer to local standards. Line currents are listed on page 1-3.

MAXIMUM ISOLATION VOLTAGE
Output common may be floated up to ±10V dc or rms from chassis to reduce common mode errors.

DIMENSIONS (Case only)
10½" (267 mm) H x 17" (432 mm) W x 24.68" (627 mm) D

WEIGHT
120 pounds (54.5 kg)

EXTENDED USAGE
The 5215A will typically provide the following extended output voltages and frequencies when the line voltage is kept at the nominal value or above:

1200V rms up to 120 kHz with 100 mA output capability.

OUTPUT CABLE
Extends three feet beyond the front panel. Special cable is used to provide remote sensing at the covered dual banana plug (with ¾" spacing) at the end of the cable. A storage receptacle is located on the front panel to hold the output cable safely when not in use. Option —07 routes the cable out two feet beyond the rear panel.

SAFETY FEATURES
When the ac power is turned on, the amplifier is automatically set to the Standby condition and a 1¼ by ½ inch red arrow (lightning bolt) is illuminated to indicate that potentially dangerous output voltages could be present due to remote programming inputs. When output voltage is commanded a ¼ by 1 inch red "OPERATE" lamp is illuminated.

Two step turn-on is provided by calling the 1000 volt range from the 5200A (local or remote modes) which causes the 5200A to return to Standby. After a 10 ms delay, the 5200A operate command can then be initiated to provide an output voltage from the 5215A.

The 5215A meets the safety requirements of IEC348.

CALIBRATION REQUIREMENTS
The 5215A is calibrated at the factory by instrumentation traceable to the National Bureau of Standards. Periodic calibration of the 5215A may be accomplished using thermal converters and other general purpose laboratory equipment.

INPUT LINE CURRENT

(At Full Load)

		100V	115V	200V	230V	
Control Supply Cord	50 Hz	2.0A	1.8A	1.0A	0.9A	(Amp rms)
	60 Hz	1.9A	1.6A	1.0A	0.8A	
High Voltage Supply Cord	50 Hz	14.5A	12.4A	7.2A	7.1A	
	60 Hz	13.9A	12.0A	6.9A	6.6A	

COOLING

Forced air cooled. Air enters through a reusable filter on the rear panel. Air exits upward from the rear panel and along both sides (Main rear panel outlet may be redirected to the right side at the rear of the instrument.)

TEMPERATURE

0°C to +50°C operating
-40°C to +75°C storage

RELATIVE HUMIDITY

0 to 80% (0°C to +40°C)
0 to 70% (+40°C to +50°C)

SHOCK

15g, 11 ms half-sine wave

VIBRATION

3.1g, 10 Hz to 55 Hz

ALTITUDE

0 to 10,000 ft (3048 meters) operating [Above 7000 ft. (2134 meters) when using 50 Hz line power derate maximum output current by 40%].

50,000 ft (15240 meters) non-operating.

REMOTE PROGRAMMING

Using the 5200A with the 5215A allows the 5200A to program the 5215A either manually from the 5200A's front panel controls or through the 5200A's remote programming input.

The 5215A is supplied with a two-foot 5200A/5215A interface cable which will allow the 5215A to sit on either side of the 5200A or on top of the 5200A. It is not recommended to put the 5215A below the 5200A due to the upward warm air discharge.

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section contains information essential for correct operation of the Model 5215A. Should any difficulties be encountered during operation, please contact the nearest John Fluke Sales Representative or the John Fluke Mfg. Co., Inc. A complete list of Sales Representatives is located at the rear of this manual.

2-3. SHIPPING INFORMATION

2-4. The Model 5215A was packaged and shipped in a foam packed cardboard carton. Upon receipt, a thorough inspection should be performed to reveal any damage in transit. Special instructions for inspection and claims are included in the carton.

2-5. If reshipment is necessary, the original container should be used. If it is not available, a new container can be obtained from the John Fluke Mfg. Co., Inc. Please reference the Model number when requesting a new container.

2-6. INPUT POWER

2-7. The power amplifier can be operated from either a 100, 115, 200 or 230V ac 50 or 60 Hz power line. A jumper system on the power supply section allows selection of the appropriate line voltage. Refer to Section 4 for selection of the proper jumper and fuse combination for the local line voltage.

2-8. INSTALLATION

2-9. The power amplifier is designed for bench-top use or it can be installed in a standard 19 inch equipment rack with mounting brackets. Rack mounting is done as follows:

a. Remove the vertical decals from the sides of the two front handle castings.

b. Remove the screws from the front corner casting which match the hole patterns in the rack mounting brackets.

c. Attach the rack mounting brackets to the corner castings with No. 8-32 PHP screws.

2-10. OPERATING FEATURES

2-11. In the Calibrator Mode the 5215A is controlled from the 5200A AC Calibrator, either from the 5200A front panel or indirectly through the 5200A Remote Control Unit. The output is the voltage selected by the 4200A on the 1000 volt range. The output sensing signal is returned to the 5200A for maximum overall accuracy.

2-12. The location and function of all front panel controls, connectors, and indicators are shown and described in Figure 2-1 and Table 2-1. The rear panel connectors and fixtures are shown and described in Figure 2-2 and Table 2-2.

2-13. OPERATING NOTES

2-14. AC Line Connections

2-15. Power is input to the unit on two separate lines. One line provides power to the high voltage system while the other supplies the auxiliary power system. Each input line is individually fused. The voltage is selectable, as previously described and the input frequency may be either 50 or 60 Hz. Both input power cords have three prong polarized plugs. The round pin on the plugs connect the chassis to earth ground, therefore ensure that it is connected to a high quality earth ground.

2-16. The 5215A requires a significant amount of line power. Table 2-3 contains the RMS line currents under full load conditions as controlled by line voltage setting and input frequency. The requirements for both the high voltage and auxiliary power line cords are listed. The high voltage line cord is rated at 18 amps.

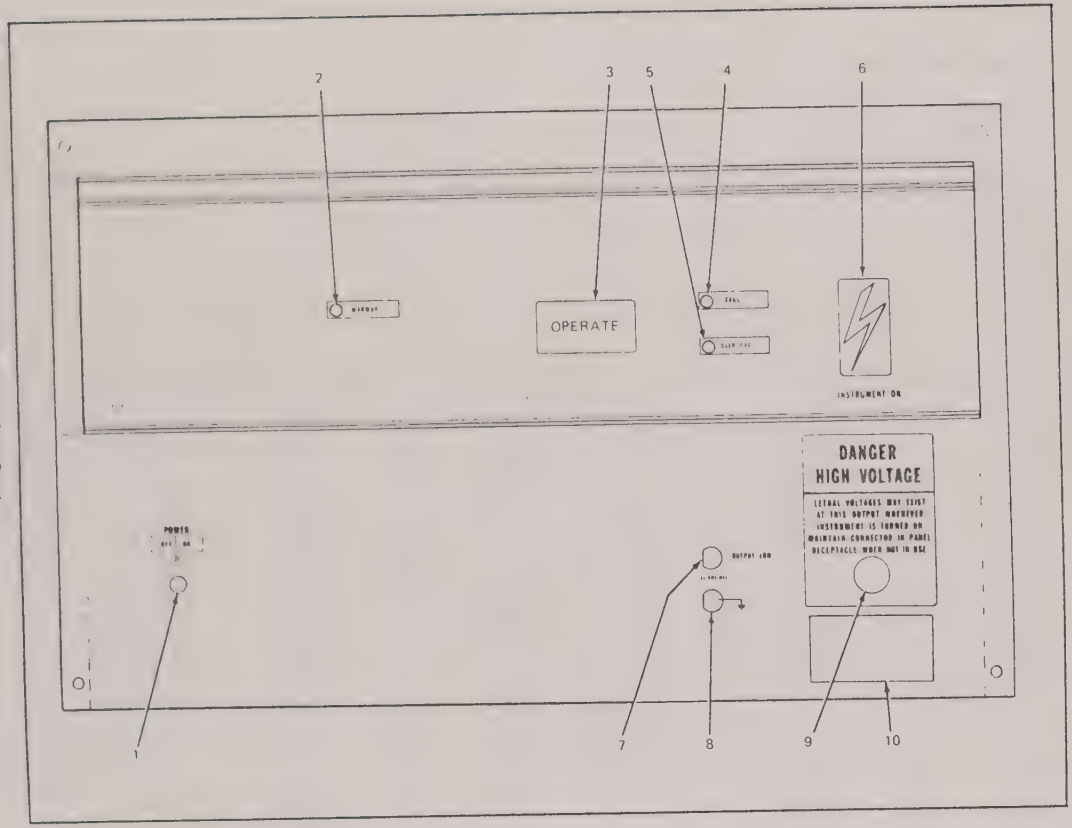


Figure 2-1. Front Panel

Table 2-1. Front Panel Component Descriptions

REF NO.	NAME	FUNCTION
1	POWER Switch	Applies line voltage to the Auxiliary (AUX) power supplies. After approximately 30 seconds power is applied to the High Voltage (HV) supply.
2	WARMUP Indicator	Illuminated for approximately 30 seconds after the POWER switch has been turned ON. This allows the Power Amplifier time to heat the tube filaments prior to applying high voltage to the system.
3	OPERATE Indicator	Illuminated when the Operate mode has been selected.
4	FAULT Indicator	Illuminated when a fault occurs in the system. A procedural or minor fault may be corrected and the indicator extinguished by returning the unit to the Reset Fault mode. This can be accomplished by returning the 5200A mode to standby and then back to operate, either from the 5200A front panel or the RCU.
5	OVERLOAD Indicator	Illuminated when an overload is placed on the power amplifier. To extinguish, power must be removed and reapplied. If accompanied by the fault indication, there is a fault condition which must be reset by turning power OFF and ON.
6	INSTRUMENT ON Indicator	Illuminated when the POWER switch is turned ON. Warns that dangerous High Voltages are present in the unit and may be present at the output terminals.
7	OUTPUT LOW Terminal	Provides a front panel connection for OUTPUT LOW. The maximum allowable differential between Output LOW and chassis is 10V ac rms, the maximum continuous current 50 mA, peaking at 5A for 10 ms
8	CHASSIS GROUND Terminal	Provides a front panel connection for chassis ground.
9	OUTPUT Terminals	Permanently attached 4-wire output cable, 3 feet in length. The Output HI and Sense HI wires were connected at the HI Terminal of the output connector. The Output LO and Sense LO wires are connected at the LO terminal of the output connector. This configuration provides the minimum capacitance required at high frequencies
10	Cable Storage	This storage area is provided as a safety feature. When the output cable is not in use, the output terminals can be inserted into the internal connectors.

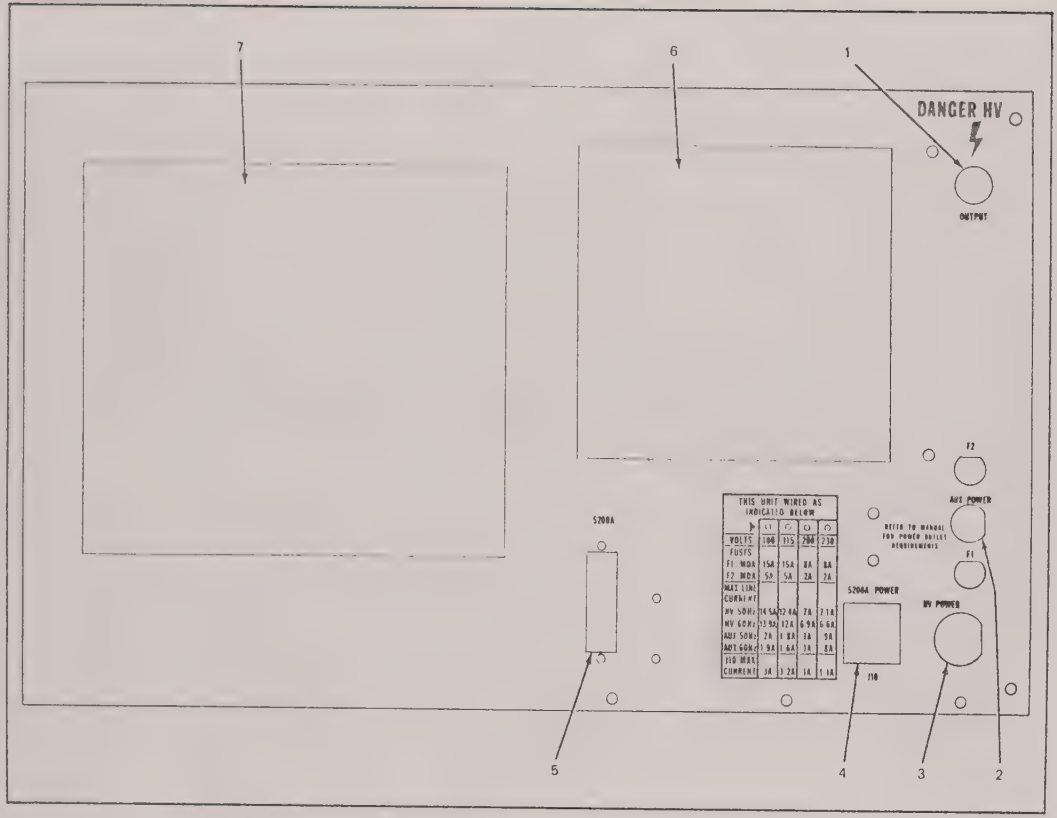


Figure 2-2. Rear Panel

Table 2-2. Rear Panel Component Descriptions

REF NO.	NAME	FUNCTION
1	Optional Output Terminals	This filler plug is removed and the output cable exits from this point if the –07 Option is installed. This option repositions the Output connector to the rear panel for system use.
2	Auxiliary Power Line and Fuse	The permanently attached, No. 16 AWG wire, three-prong power cord supplies the line voltage to the auxiliary power supplies and 5200A power through F2, a 5 amp Slo-Blo fuse.
3	High Voltage Power Line and Fuse	The permanently attached, No. 14 AWG wire, three-prong power cord supplies the line voltage to the High Voltage Power Supply through F1, a 15 amp Slo-Blo fuse.
4	Convenience Outlet	The power available at the convenience outlet is taken directly from the auxiliary power line input. It is a standard American style 3 prong connector.
5	5200A 25-Pin Connector	Input for signal and controls from the 5200A.
6	Air Intake and Filter	Washable filter to clean air used to cool the unit.
7	Air Outlet	Shield directs flow of air exhaust. Normally, exhausted air is directed upward, however, the shield can be removed and repositioned to direct the air flow to the right of the instrument, if this path of flow is obstructed in some manner. It should not be positioned to the left toward the air intake or downwards.

Table 2-3. Input Line Currents

SUPPLY	INPUT FREQ	INPUT VOLTAGE			
		100	115	200	230
HV	60 Hz	13.9	12	6.9	6.6
AUX	60 Hz	1.9	1.6	1	0.8
HV	50 Hz	14.5	12.4	7.2	7.1
AUX	50 Hz	2	1.8	1	0.9

2-17. The operator must verify that local and/or national standards for outlet receptacle and branch circuit are met. For example: In the Unites States a 20A rated branch circuit is required for a 115V ac 60 Hz source. The 5215A connectors are rated at 15A and can be plugged into either a 15A or 20A rated outlet.

2-18. Input Connectors

2-19. Control of the 5215A is from a connector on the rear panel. Both the input signal and controls are made through a 25-pin connector.

2-20. Output Connections

2-21. The output cable is permanently attached to the unit at the front panel. As part of the —07 Option, it can be attached at the rear panel for system operation. The 3-foot long, four-wire, low capacitance cable has a hooded protective cover for operator safety. Selection of the —07 Option for a rear connector reduces the length of the output cable to two feet. Remote sensing is accomplished by connecting the Output and Sense HI lines and the Output and Sense LO lines inside the sealed protective cover.

2-22. Output Capabilities

2-23. The 5215A can deliver up to 200 mA rms ac. Attempts to draw currents in excess of this amount result in an overload which removes the output and causes the amplifier to either retry its programmed output or to return to standby. Before using the 5215A as a source, insure that the recipient unit does not load the amplifier in excess of these limits.

2-24. Ground Connection

2-25. If desired, the amplifier OUTPUT LOW can be grounded to the chassis at the front panel by connecting a shorting link between the two terminals. The chassis ground is connected to an earth ground through the line cords, provided the ac line cord is properly grounded. If floating the amplifier output above ground is desired, when the load cannot be disconnected from the earth ground, remove the shorting link from between the two front panel terminals and connect the OUTPUT LOW terminal to the earth ground on the load. The maximum allowable differential between OUTPUT LOW and chassis ground is 10V ac rms.

CAUTION!

The OUTPUT LOW terminal of the 5215A should never be left floating during operation. If the strap between OUTPUT LOW and CHASSIS GROUND is not present, then verify that through the output cable and the load, a connection with CHASSIS GROUND is present.

2-26. System or Combined Operations

2-27. The 5215A can be directly combined with a 5200A for operation, or through a Remote Control Unit (RCU) controlled by a computer test system.

2-28. Calibrator Operation

NOTE

During combined operations, the 5200A should not be positioned on top of the 5215A. Overheating can result when the 5200A intakes discharged air of the 5215A. Also, transformer coupling may result at line related frequencies.

2-29. 5200A LOCAL OPERATION

2-30. Once the 5215A is prepared for operation, i.e., the 5200 Control Cable connected, the POWER switch is ON and the 5200A in the 1000V range, control of the 5215A rests with the 5200A. The following procedure can be followed to operate in the calibrator mode:

a. Connect the control cable between the J32-5205 connector on the 5200A and the 5200A Remote Connector on the rear panel of the 5215A.

b. Set the POWER switch to the ON position.

c. The INSTRUMENT ON and WARMUP indicators are illuminated.

d. After a delay of approximately 30 seconds the WARMUP indicator extinguishes.

e. Select the desired amplitude (1100V rms max) and frequency (100 kHz max) on the 5200A front panel.

f. Set the 5200A mode switch to OPERATE.

g. The OPER indicator on the 5200A and the OPERATE indicator on the 5215A illuminate. The STDBY indicator on the 5200A extinguishes. The voltage selected on the voltage dials (100 to 1100 volts) is present at the output connector.

NOTE

In case of a fault, the 5215A will return to STDBY. The 5200A will still be in the OPERATE mode, although the indicator will show STANDBY. Reset the fault by turning the STDBY-OPER switch on the 5200A front panel to the STDBY position.

2-31. 5200A REMOTE OPERATION

NOTE

For operation of the 5200A Remote Control Unit (RCU) see Section 6 of the 5200A manual.

2-32. When the 5200A is controlled by an RCU during Calibrator Operation, the timing of the Range Select and Operate commands becomes critical. Two separate transfers, separated by at least 10 ms, are required to obtain proper operation of the 5215A. Use the following format for the two transfers.

a. First transfer command should include:

1000 Volt range
Standby
Any other controls and setting desired.

b. Second transfer command should include:

1000 Volt range
Operate
A repeat of any other controls and settings in the first transfer command

NOTE

At least 10 ms must elapse between the two transfer commands. The READY STATUS flag may be used for timing between the two transfer commands or ignored.

2-33. Changes in settings and controls, including Standby and Operate are accepted in one transfer by the RCU as long as the 1000V range is included. The RCU Ready flag delay varies with the selected frequency of the 5200A due to settling time within the instrument. If the flag is to be used for timing, check the 5200A manual for those specifications.

2-34. Operate Fault

2-35. A fault will result from an invalid Operate command. If the MODE switch is set to the OPERATE position prior to the expiration of the warmup period the FAULT indicator will illuminate. Clear the fault and extinguish the indicator by returning the MODE switch to STDY and then, after the WARMUP indicator has extinguished, return the MODE switch to OPERATE.

2-36. Equipment Faults

2-37. Fault indications also result from internal instrument failures, such as: no cooling, severe overloading of the high voltage power supplies or high voltage present during the warmup period. This type of fault disrupts the amplifier loop causing the OVERLOAD indicator to illuminate in addition to the FAULT indicator. Returning the MODE switch to STDBY does not clear this type of fault. Restart the system by turning the POWER switch to OFF, then ON, wait 30 seconds for the WARMUP indicator to extinguish then set the 5200A MODE switch to OPERATE. Insure the 5200A is in Standby before starting the restart procedure. If the FAULT and OVERLOAD conditions persist, repair of the instrument is required.

Section 3

Theory of Operation

3-1. INTRODUCTION

3-2. This section contains the theory of operation for the Model 5215A Precision Power Amplifier. The theory description is presented first in a simplified block diagram (Figure 3-1), then a functional block diagram, and then a circuit explanation. A complete set of schematic diagrams is contained at the rear of the manual.

3-3. The 5215A Precision Power Amplifier provides amplification at the fixed gain of minus X100 to any signal input, up to the specification limits of 1100V ac rms at 100 kHz.

3-4. SIMPLIFIED BLOCK DIAGRAM DESCRIPTION

3-5. Selection of the operating mode and status is done within the Logic Assembly. When power is applied the Initializing circuit readies the system while the instrument is checked for faults. The signal to be amplified and control signals are applied from the 5200 connector on the Rear Panel, provided the 5200A has the 1000V range selected.

3-6. The signal is amplified in the preamplifier then applied to the power amplifier. The power amplifier is a Class AB push-pull type using two tubes connected in parallel in both the upper and lower portions of the circuit to provide sufficient output current capability. The output is sensed and returned to the preamplifier to control the input by controlling the output from the 5200A.

3-7. The Power Amplifier is supplied with ±2.5 kV and the Preamplifier with -2.5 kV. The various low voltage power supplies and regulator within the instrument are supplied from the Auxiliary Supplies.

3-8. Power Supply Assembly

3-9. Line Power is input to the Power Supply Assembly on two different line cords. Power for the high voltage circuits enters on P8 and for the Auxiliary circuits on P9. This allows operation of the Auxiliary circuits while troubleshooting and or calibration without the danger of the high voltage circuits. The high voltage circuits output ±2.5 kV to the Power Amplifier and -2.5 kV to the Preamplifier. Details on the various portions of the high voltage circuit and the auxiliary voltages available are contained in the following sub-paragraphs.

3-10. HIGH VOLTAGE RELAY DRIVER

3-11. Power applied to the instrument cannot reach the High Voltage Transformer until K1 is energized. P56-8 brings in the control signal from the Logic Assembly. This signal goes low approximately 30 seconds after the POWER switch is set to the ON position. Prior to that time the Optical Isolator U1 has been cut off, preventing K1 from energizing. Once low, U1 conducts, cuts off Q1, which causes the current source Q2 to turn on Q3 and energize K1. Q2 also supplies current to the zener VR5 to provide a regulated 110V to the relay coil, optimizing the dissipation of the relay under varying line voltages. Diodes CR1 through CR4 and C1 provide a 110V supply to the relay driver.

CAUTION!

The Relay Driver circuitry is located on the Primary side of the HV Transformer. Extreme care should be taken when connecting any test instruments to the circuitry.

3-12. POWER AMP ±2.5 kV SUPPLY

3-13. Operation of both the positive and negative supplies are identical. The positive voltage supplies V1 and V2 on the Tube Mounting Assembly while the negative supply goes to V3 and V4 on the Lower Tube

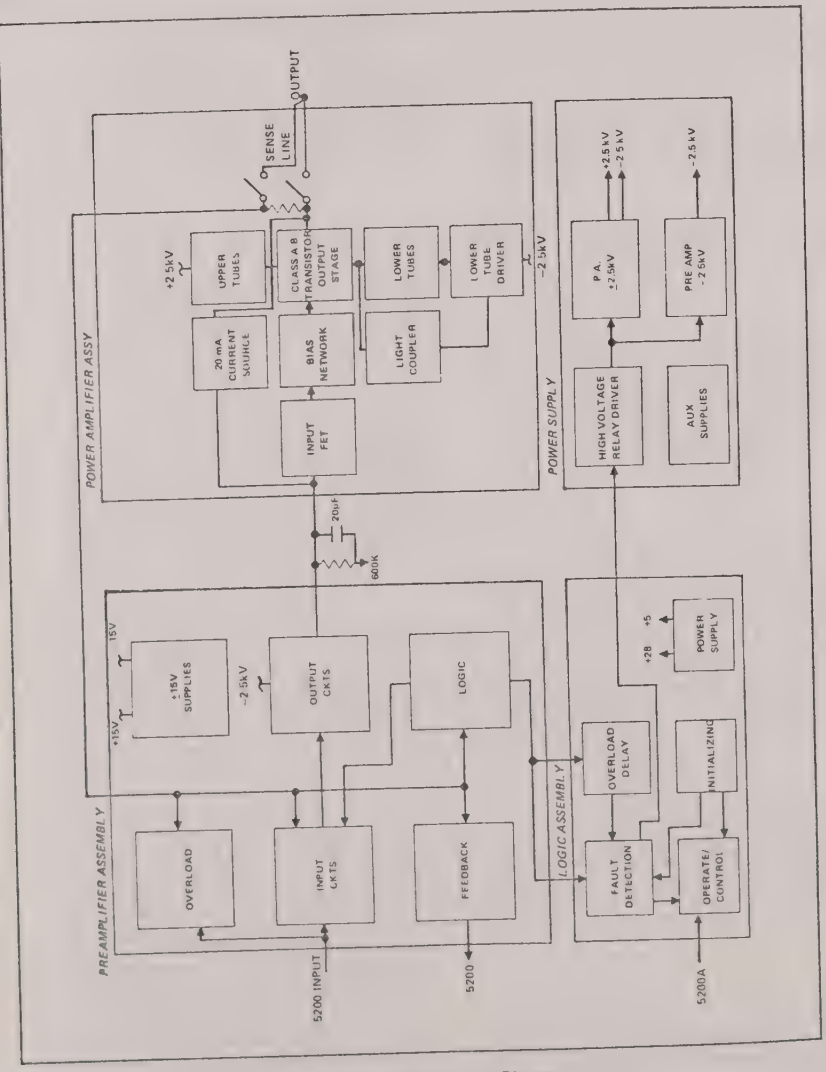


Figure 3-1. Model 5205A Block Diagram

Assembly. In both cases the transformer secondary is rectified by a bridge rectifier and then filtered by C11 or C12. Each Supply has a bleeder assembly connected to provide a discharge path for the filtering capacitor if the Power Amplifier is not connected to the circuit. Discharge takes approximately 30 seconds. Each circuit has a decoupling network consisting of a resistor (R22 and R12) and two diodes (CR25, CR26 and CR17, CR18). A monitor to the Logic Assembly is provided from each supply.

3-14. PREAMP -2.5 kV SUPPLY

3-15. The Preamp supply rectifies the transformer secondary with CR13 and CR14 and then filters it with C13. A bleeder assembly is provided to discharge the filtering capacitor to a safe level if the Preamp is not installed. Discharge takes approximately 30 seconds. This Voltage supplies the -1.9 kV regulator on the Preamp.

3-16. AUXILIARY SUPPLIES

3-17. Line power input on the auxiliary power circuit is tapped to provide an outlet for the 5200A on the rear of the instrument. It also supplies inputs to the primary of the Preamplifier Auxiliary Transformer T3, the Power Amplifier Auxiliary Transformer T4 and the Low Capacity Transformer T2. Outputs from the Low Capacity transformer secondary are used on the Power Amplifier.

3-18. Logic PCB Assembly

3-19. When power is applied to the instrument the initializing circuits prepare the circuits for operation. Control is exercised through the operate/control stage, with control originating at the 5200. Any fault and/or overload will be detected and returned to the operate control stage for appropriate action. The +5 and +28 power required for the logic and relay circuits are generated within the Logic Assembly.

3-20. INITIALIZING CIRCUITRY

3-21. When power is applied to the instrument U42-5 goes high from the Warmup Delay circuit to disable U14-10, which prevents the high voltage control relay from energizing, also U2-6 goes low disabling the overload circuitry. At the same time U20-2 goes low to illuminate the Warmup indicator, clear the Operate FF at U4-13 and enable U14-12 so that if high voltage is present it will clear the Trouble FF and generate a fault. The length of the Warmup period is controlled by R129 C53 and should be approximately 30 seconds. The Power Up Initialize circuit (R131/C54) generates a pulse at Power Up to set the Trouble FF. It also, through the fault gate, insures the Operate FF is cleared, so both devices start in a known condition.

3-22. Once the Warmup delay period has passed U42-5 goes low, extinguishing the Warmup indicator.

3-23. OPERATE/CONTROL

3-24. The operate command originates from the 5200A interface. it is wire ORed with a permanent HIGH at U2-3 for the control line and U4-9 for the operate line.

3-25. The U30 optical isolator returns the status and overload conditions to the 5200A. Control of the inputs is discussed later.

3-26. 5200 Interface

3-27. The control command at P41-6 activates half of U31 for a high at U4-6 which enables U3-9 for the upcoming operate command, enables U3-5 for the return status, and pulls the control line low at U2-3. In addition U1-8 and P44-7 go high after a 33 ms delay for use in the preamplifier. The low at U8-6 activates K1 to connect the 5200A guard to sense low in the 5215A.

3-28. Operate FF

3-29. Once U2-3 has been pulled low by the interface, R124 C44 delays the signal 3 to 9 ms. At the end of this delay the Operate FF J Input, U41-4 goes high. The operate command is delayed slightly by R121/C43 and then applied to U41-1 as a low going clock to set the $\overline{Q}$ output low. This is used to set U5-6 high to return the status to the interface, to output a low $\overline{5205A\ OPERATE\ COMMAND}$ at P44-3, and to turn on Q1 and Q2 which illuminates the OPERATE incandescent lamps and outputs a low to the power amp at P43-27, 28. The high at the Q output is applied to U43-10 and U14-1 for use in fault detection.

3-30. If the control line was not high at the Operate FF prior to the arrival of the operate command the flip-flop would not be clocked and a fault would result. Since the delay in the control line appreciably exceeds that of the operate line the control signal in any remote or 5200A operation must precede the operate command by at least 10 ms.

3-31. FAULT DETECTION

3-32. Two types of faults can exist within the system. A major fault requres the removal of power to clear the fault detection system. A minor fault can be cleared by setting the mode switch to STDBY-RESET and then returning it to OPERATE.

3-33. Minor Faults

3-34. A minor fault uses the fault gate output, delayed by R122/C41, to clear the Operate FF, which returns the instrument to standby and illuminates the fault indicator. Minor fault inputs to the fault gate come from U43-8 when the operate FF is set but there is no operate command and from the dual control error detection circuit when two or more control signals are present. Inputs are also supplied from the U21 quad comparator. The output at U21-14 goes low if the -I limit sensor has a current greater than 200 mA for a time period determined by R88/C23. The +I limit sensor goes low at U21-13 when the comparator senses a voltage greater than 200 mV. The +5V limit sensor goes low at U21-1 when the +5 volt supply drops to 4.5 volts.

3-35. The absence of the $\overline{\text{NEG HV}}$ signal at P44-1 from the preamp applies a low at U15-4 which clears the Operate FF, after the delay of R122/C41. The resulting low at U14-1 is combined with the low operate command at U14-2 to illuminate the fault indicator. This gate will also operate if the operate command clocks the flip-flop when there is no control signal present. Both conditions will cause a minor fault without using the fault gate.

3-36. Major Faults

3-37. A major fault clears the Trouble FF, in addition to generating a fault signal from the fault gate. The only method of setting the Trouble FF to remove the major fault is the Power-Up Initialize circuit, necessitating removal power from the system and then resetting the power switch to ON.

3-38. The quad comparator U22 activates the Trouble FF if either U22-1 or U22-2 are brought low when the NEG Supply current monitor at P43-12 or the POS Supply current monitor at P43-10, respectively, exceed their 300 mA limits for 100 ms. U22-14 will go low if the signal from the Fan switch is interrupted for approximately 6 seconds. The fourth comparator input is the overdrive which originates in the preamp. If the overdrive signal goes high, U22-13 will go low and clear the Trouble FF, shutting down the system.

3-39. If the transistors Q1 and Q2 do not operate properly, i.e. Q1 conducting and Q2 cut-off, Q3 is turned on activating the Trouble FF. The +28V limit sensor in the U21 comparator will turn Q4 on when the input drops to 20V, cutting off Q2 and activating the trouble circuit.

3-40. A major fault is also generated when high voltage is sensed at P43-8 during the Warm-Up period. The signal, if present, will turn on Q10 to enable U14-13 so that when U14-12 is low during warmup the trouble FF is cleared.

3-41. OVERLOAD DELAY

3-42. The overload signal at P44-5 from the preamp illuminates the OVERLOAD indicator and activates the trip isolators in the selected interface device. Since it does not generate a fault and the overload pulse could be quite narrow a one-shot is installed in the circuit to give a minimum width pulse. The width of the pulse at U42-9 is determined by R126/C47 and is approximately 0.5 seconds.

3-43. POWER SUPPLIES

3-44. +28V dc

3-45. The 21V rms at P43-17, 18 and P43-19, 20 is rectified at CR18 and filtered by C28. The 21V rms operates the incandescent lamps in the INSTRUMENT ON (lightning bolt) indicator. The +28 volts is used for the OPERATE indicators and various relays. The +28V is also used with Q5 and series regulator circuit to develop 5.6 volts for the pull-up resistor R73.

3-46. +5V dc

3-47. U25 is a 5 volt regulator which acts on the 8.5V rms supplied from the power supply. It is rectified at CR17 and filtered by C25-C27. Up to 400 mA is supplied for the use of the IC's on the logic assembly. Capacitors C1, C3, C10, C12 and C46-C56 are used for decoupling the integrated circuits on the assembly.

3-48. Preamplifier Assembly

3-49. The signal to be amplified enters the Preamplifier (Fig. 3-2) on the 5200 connector. The input signal is amplified and internal feedback applied to set the gain at 100 within the Input circuits. In the Output state the instrument output voltage swing of ±1550 Volts is set. The output is sensed and returned to the Input, Logic, Overload and Feedback circuits. The Feedback circuit takes the sensed voltage, divides it and feeds it to the 5200A for use in stabilizing gain and control. The Overload circuits sense high output voltages or low supply to cut off the input to the preamplifier. The Logic circuits decode control inputs and supply status outputs to the Logic PCB. The ±15 volt power supply provides regulated ±15V dc to components on the preamplifier.

3-50. INPUT CIRCUITS

3-51. Input and Feedback Resistor Network

3-52. The gain of the 5215A is controlled with this circuit. The ratio of the 1M (R302) to the input resistance gives a gain of 100. R301 (10k) and the resistance of Q121 (40Ω) combine for the hundred to one ratio.

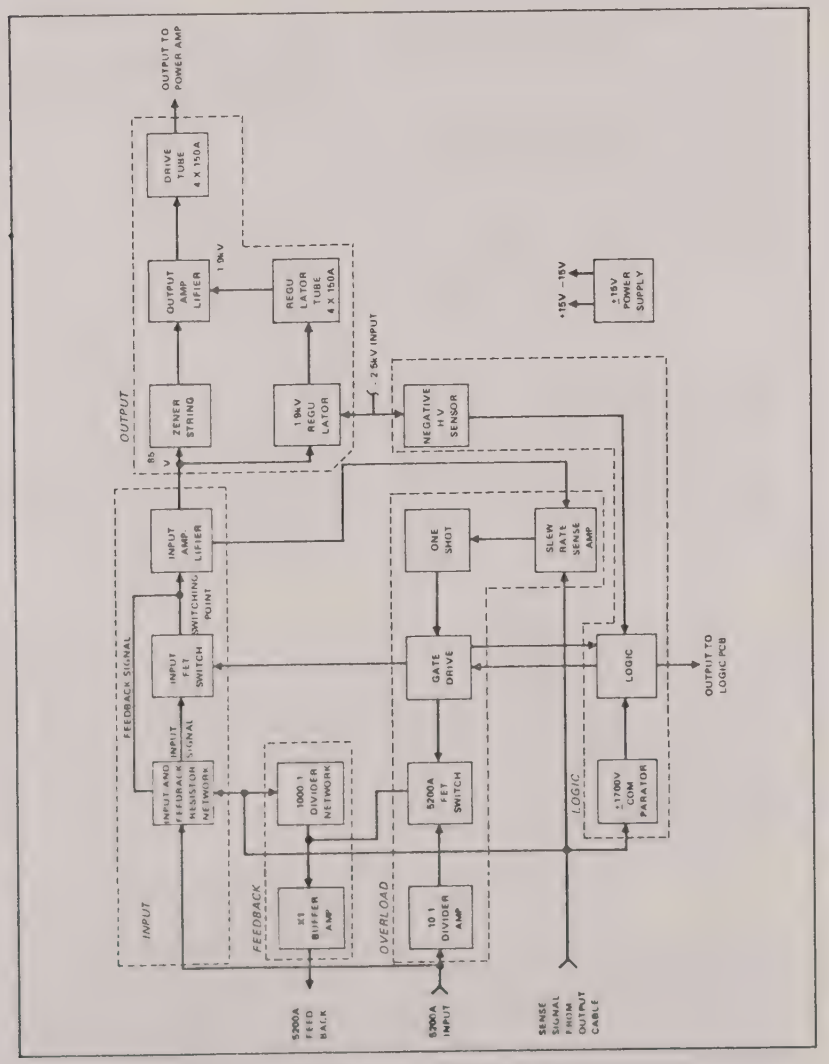


Figure 3-2. Pre-Amplifier Block Diagram

3-53. Input FET Switch

3-54. Q121, the input FET switch interrupts the input signal when the instrument is in standby or overload. Since the resistance of Q121 is part of the input resistance any change in temperature will effect the resistance of the FET and through it the gain of the instrument.

3-55. Input Amplifier

3-56. Transistors Q128, Q132, Q138, Q140, Q147 and Q148 is conjunction with the Op-Amp U123 and their associated components make up a wide band dc coupled amplifier, which is the input amplifier. The input signal and feedback is summed at Q128, routed through Q132 and Q140 and then output to the next circuit at Q148. Transistors Q138 and Q147 provide current sources of 1.8 mA and 3 6 mA respectively. Op-Amp U123 keeps the instrument output offset near zero. Any dc voltage at the summing point is amplified by U123 and applied to the source of Q128, where it is amplified by the remaining stages. At the output the feedback, through R302 brings the summing point back to zero. Since the dc gain of U123 is high the dc offset of the instrument is determined by the characteristics of U123. Above 20 kHz the gain of U123 is rolled off by C124 and R127 so that the source of Q128 is held to zero volts ac by C128. As a result the gain of the input amplifier is determined by Q128 and the load capacitance at the collector of Q132 above 20 kHz.

3-57. OUTPUT CIRCUITS

3-58. Zener String

3-59. The zener string provides a dc path from the input amplifier across a potential of 1900 volts to the output amplifier. In the string the 50V, 100V and two of the nine 200V zeners are shorted with a jumper that can be removed to adjust the voltage on the output amplifier common to between -1850 and -1910 volts. The bias current through the string is the 3.6 mA supplied by the current source Q147. Frequencies above 150 kHz are bypassed around the string by C192.

3-60. Output Amplifier

3-61. After the zener string the input signal current goes to the output amplifier which provides an amplified low distortion current to the drive tube. Common for the output amplifier is kept at -1.9 kV dc potential, as set by the -1.9 kV regulator which allows the drive tube plate to fall to the -1550 volts required by the instrument output and still maintain the bias required on the tube. The amplifier consists of transistors Q182 through Q187 which are supplied a ±29V dc from C182, C183, CR182 and the 40 rms input Q185 is used as a current source to take 1.7 mA of current from the 3 6 mA supplied by the zener string. The remaining 1.9 mA provides the amplifier with a full scale swing of ±1.9 mA so that when the signal swings -1.9 mA the output current to the tube is zero but the zener string remains biased to 1.7 mA from the current source. This bias keeps the impedance of the zener string low and prevents the distortion that would normally occur at the knee of the zener. The output from the amplifier at the emitter of Q182 is set in magnitude by Resistor R195 and the base voltage. This is applied to the cathode of the drive tube to develop the instrument output voltage at the tube plate. Distortion in the current output of Q182 is reduced by the diode connected transistors Q184, Q186 and Q187. The same voltage should appear across R195 and R197, therefore if 1.9 mA flows in R197 a current of 30 mA will flow in R195 and in turn in Q182 and the drive tube, providing the normal bias for the tube.

3-62. Drive Tube

3-63. The drive tube develops the instrument output voltage swing of ±1550 volts. Current from the output amplifier changes the tube plate to cathode voltage in response to the input signal thereby generating the instrument output. The screen grid voltage is set by VR185 and the resistor string R204 through R207. The plate load consists of R1 through R4, four 150k resistors in series, and the 20 pF inherent in the tubes plate to plate shield and the coaxial cable (plate to power Amp input) capacitance.

3-64. -1.9 kV Regulator

3-65. Regulation of the -1.9 kV at the Output Amplifier common is accomplished by regulating the input voltage to the zener string. As long as the input at the zener string is -85 volts the voltage at the injunction of R151 and R158 and at U157-3 will be zero. Since U157-2 is tied to common and change in the zener string input will effect the U157 OP Amp, and in turn Q161 and the optical coupler U160. The signal is passed across the coupler to the photo transistor which drives Q177 which drives the regulator tube V2, changing the common of the output amplifier and the input to the zener string, bringing the loop into balance. Q176 is used as a current limiter for the regulator and is set for a limit of 55 mA.

3-66. FEEDBACK CIRCUITS

3-67. 1000:1 Divider Network

3-68. Sense voltage for the 5200A is divided down to the required level by the 1000:1 divider network. The high voltage on the sense line is applied to the 1.0009M resistor (R304) and divided by 1.019k (R303) and the shunt resistors R8 and R9 to give a 1000:1 ratio. Resistors R303 and R304 are deposited on a substrate to provide good thermal tracking which keeps the division ratio constant

with temperature and self-heating. The substrate is mounted in a milled aluminum can for heat dissipation and must be replaced as a unit.

3-69. Buffer Amplifier

3-70. A unity gain amplifier (U12) is used to drive the coaxial cable carrying the divided signal to the 5200A. During instrument overload, input to the Buffer Amplifier comes from the 10:1 divider amplifier in the overload circuit. R14, R15, C14 and C15 provide frequency compensation for the divider and buffer network.

3-71. OVERLOAD CIRCUITS

3-72. Slew Rate Sense Amplifier

3-73. If the difference in the slew rate voltage between the input amplifier rate and an output sample rate exceeds a voltage detected by a differential amplifier (125 mV) a trigger is provided to the one-shot multivibrator, putting the instrument into overload. The input signal is taken from the emitter of Q148, divided 10:1 by R110 and R109 and applied to one input of the differential amplifier Q104. The other input to Q104 is a sample of the output as developed across R108 and R111 and coupled from the sense line by C91. Q105 is a 5 mA current source, provided 2.5 mA to each side of the differential amplifier. Q103 and Q106 each provide 3.75 mA to the collectors of the differential amplifier. As a result both Q101 and Q102 are biased off, as long as the differential is balanced. When the differential input to the amplifier reaches 125 mV either Q101 or Q102 turns on and provides an input to the one-shot multivibrator Q92 and Q93, thereby, putting the instrument into the overload mode.

3-74. One-Shot

3-75. In the one-shots quiescent state, Q92 is conducting and Q93 is cut off. When triggered by the slew rate sense amplifier a 5 Volt pulse is provided from the collector of Q93 to the gate drive circuit for a 4 ms period.

3-76. Gate Drive

3-77. Transistors Q37, Q42, Q43, Q44 and their associated components comprise the Gate Drive circuit. When the one-shot is triggered the resulting pulse turns on Q42 and Q37, enabling the gate of the FET switch Q7 and connecting the 10:1 divider to the buffer amplifier. Q43 is turned from Q42 which turns off the input FET switch and removes the input signal from the input amplifier. Q43 can also be turned on from the Logic circuit (Q45) to prevent the input signal from reaching the input amplifier when the instrument is in standby.

3-78. 10:1 Divider Amplifier

3-79. With the instrument in overload it closes the loop back to the 5200A, preventing the 5200A control loop from developing large errors when there is no feedback signal from the 5215A. Gain of the amplifier, U7, is set by the ratio of R7 (5.23k) to R6 (49.9k) which equals 0.105. Application of the amplifier to the buffer amplifier is controlled by the 5200A FET switch.

3-80. 5200A FET Switch

3-81. When an overload condition enables the gate drive the 5200A FET switch Q7 is turned on, providing a path for the 10:1 divider amplifier output to the 1000:1 divider network. This low impedance output overrides the signal from the 1000:1 divider network, closing the loop to the 5200A. When the overload is removed the FET switch will automatically turn off after a 3.5 ms delay.

3-82. LOGIC CIRCUITS

3-83. These circuits provide the decoding logic for the control inputs and supply the status output to the Logic PCB. Input is the $\overline{5205\ \text{OPERATE COMMAND}}$ to set the mode of operation. Status signals output are called OVERDRIVE, $\overline{\text{NEG HV}}$ and $\overline{\text{OVERLOAD}}$.

3-84. Logic Control

3-85. The $\overline{5205\ \text{OPERATE COMMAND}}$ is low for operate, activating half of U51. With the coupler transistor on, both Q45 and Q43 will be off, allowing the Input FET switch to turn on and the instrument to go into operate.

3-86. When an overload condition exists Q37 in the Gate Drive circuitry turns on, turning on Q40 and activating half of the coupler U52. With the coupler transistor on, $\overline{\text{OVERLOAD}}$ goes low, providing a status output to the logic PCB.

3-87. ±1700V Comparator

3-88. The output voltage is sampled and divided by R59 (9.53m) and R67 (56.2K) then applied to one input of the comparators U64 and U65. A +10V reference from the divider R63 and R64 is applied to the other input of U64. Divider R66 and R65 supply a -10V reference to comparator U65. As long as the output voltage is less than ±1700 Volts the outputs of both U64 and U65 stay high allowing current to flow in Q62 and U62, and in U52, provided the output of U167 is low. When the out-

put exceeds ±1700 the appropriate comparator output goes low, turning off Q62, U62 and U52. With no current flow in U52 and U62 the OVERDRIVE and $\overline{\text{NEG HV}}$ logic signals to the Logic PCB go high, setting the $\overline{\text{NEG HV}}$ logic signals to the Logic PCB to high, setting the instrument to Standby and opening the input FET switch. With no input the output should drop to zero and Q62 turn on again for a normal overload. If the overload remains after one second it is an indication of a malfunction and a fault results.

3-89. Negative High Voltage Sensor

3-90. The negative high voltage is sampled by the divider R170 through R174 and R167 and applied to one input of the comparator U167. The other input has a +5 Volt reference from the zener VR166 and the divider R157, R154 and R156. As long as the negative high voltage is more negative than -2225 Volts the output of U167 is low and current flows through the coupler U52. If the output becomes less negative than -2225 a high output results at the coupler U52, setting the instrument to standby.

3-91. +15V Power Supplies

3-92. A 31V rms input from the Auxiliary power supplies is rectified by CR70 to produce ±20V unregulated. This is filtered by C70 then Q79 is a series pass to reduce it to +15V dc. The +15V is sampled by the divider R80, R81 and R82 and compared to the reference in U79. Any difference between the reference and the sample is amplified by U79, driving the base of Q79 to keep the output at +15Volts. R79 is the current sense resistor which allows U79 to limit the output current to 160 mA.

3-93. The -15 Volts is obtained from the unregulated supply through the filter C71 and the series pass transistor Q76. The +15 is used as a reference and is connected to the Op Amp U75 through R73. The -15 is connected to U75 through R74 and since both resistors have the same value the input to the amplifier at the R73-R74 tie-point is zero when the negative output is -15 Volts. Any difference will be applied to the base of Q76 to return the negative output to -15 Volts. Q77 is a current limiter to hold the maximum output current to 80 mA.

3-94. Power Amplifier Assembly

3-95. The Power Amplifier, as shown in Figure 3-3, is basically a class AB push-pull type amplifier. The upper tubes (V1 and V2) are connected in parallel to provide sufficient output current capability for the positive portion of the output. The Lower tubes (V3 and V4) are connected in the same manner for the negative portion of the output. The low output impedance in the output stage is achieved by using a complementary emitter-follower output driven by the Input FET Q4. Bias is provided by a network consisting of Q8 and its associated components. The upper tubes have their screen and control grids indirectly connected to the output terminals so the cathode output of the tubes is always slightly higher than the output voltage. This protects the drain of the input FET (Q4) and the collector of the NPN half (Q11) of the complementary emitter follower in the output state. As a result, the voltage from the output terminal to the tube cathodes is in the range of 5 to 40 volts, which provides adequate breakdown protection for the solid state components. The Lower tubes and the Lower tube driver (Q150) are controlled by an auxiliary feedback loop, using the light coupler (U165). The purpose of this loop is to control the base to collector voltage of the PNP half of the emitter-follower (Q12) to approximately 5 volts. This has been accomplished by arranging the feedback so that current through the 30 mA current source (Q14) remains constant, which provides the input to the zener VR15, which in turn sets the 5 Volts for Q12 in the output stage. As long as the output capability of the amplifier is not exceeded and current flows in the 30 mA current source the circuit is able to hold the Q12 base-to-collector voltage almost constant.

3-96. The signal path through the circuit is detailed in the following procedure. It is assumed that the LED loop is stabilized with 30 mA of current through the LED prior to an input signal. When a small negative voltage is applied to the circuit as an input the FET Q4 acts as a source follower and translates the change in voltage directly to the base of the output followers Q11 and Q12. The immediate response is to decrease the current in Q11 and increase it in Q12, as determined by the output load. Since the loop is stabilized the plates of the V3/V4 combination are an extremely high impedance, the increasing current in Q12 flows into the emitter of the LED driver Q14, decreasing the current through the LED. As a result, the current in the PIN half of the coupler is decreased and the net input current to the amplifier Ao is negative. This slews the input node capacitance of approximately 42 pF negative, resulting in a positive output at the base of Q150, which is effectively connected in cascade with the V3/V4 combination. This increases the plate current through V3/V4, which tends to return the current through Q14 to its nominal 30 mA value. The total current excursion in the LED diode is proportional to the time derivative of the total negative tube current. With the approximate transfer ratios and curcuit values shown in the simplified schematic (Figure 3-3) the bandwidth of the light coupled loop is approximately 2.5 MHz. In actual usage the loop bandwidth is set to 2.5 MHz by adjusting C162 for 30 mA peak-to-peak in the LED with a 100 ohm load at 100 kHz.

3-97. In normal operation the nominal 2.2V dc bias (Q8 and associated components) between the bases of the

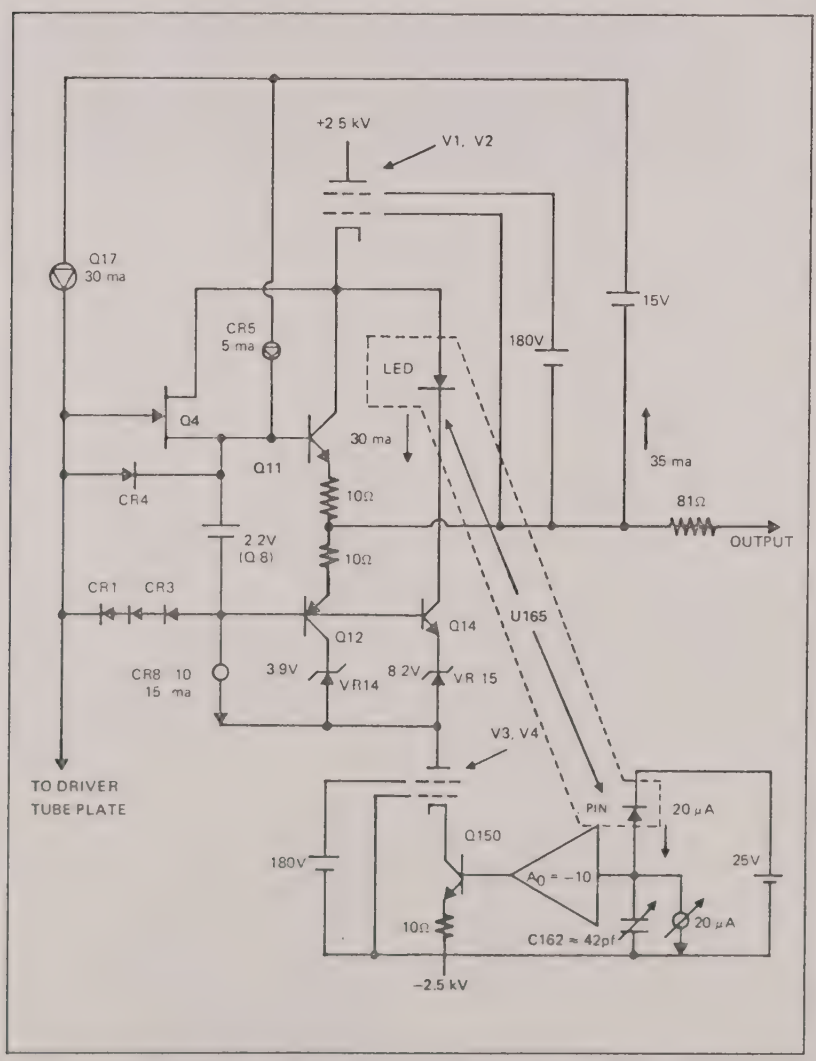


Figure 3-3. Simplified Power Amplifier Schematic Diagram

complementary output followers is adjusted so that 30 mA of current is flowing through Q12 and 65 mA through Q11. The extra 35 mA in Q11 is required to provide the current used by the current sources Q17 and CR5. The current in these sources does not return to the output mode of the amplifier but ends up flowing through the driver tube plate and the plates of the negative drive tubes. When the output load requires a very small current excursion the amplifier remains in a class A configuration with both Q11 and Q12 slightly on. As the output current raises in the positive direction the current through Q12 decreases and is completely cutoff when the output exceeds +60 mA. For more positive current all the remaining current necessary comes from Q11 and the positive drive tubes V1/V2. Conversely, Q11, is cutoff for negative output currents in excess of 130 mA and the current is provided from Q12 and the plates of the negative drive tubes V3/V4.

Section 4
Maintenance

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section contains information on General Maintenance, a Performance Verification test, a Calibration procedure and Troubleshooting information. The calibration procedure should be performed on a periodic basis (90 days) to detect the need for and to make required adjustments. The performance verification test can be used upon receipt of the 5215A and any other time desired to verify the correct operation of the equipment. The troubleshooting procedures will aid in the isolation of a fault to a particular PCB assembly and further, to a circuit or particular section of the PCB.

4-3. SERVICE INFORMATION

4-4. Each instrument that is manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of one year upon delivery to the original purchaser. The WARRANTY is located at the front of the manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various world-wide locations. A complete list of domestic service centers is located in Section 7 of this manual. Shipping information is given in Section 2. If requested, an estimate will be provided to the customer before any repair work is begun on instruments that are beyond the warranty period.

4-6. GENERAL MAINTENANCE

4-7. Cleaning Instructions

4-8. Periodically (at least every 90 days) clean the 5215A to remove dust, grease and other contaminants using the following procedure:

a. Insure power is removed from the 5215A.

b. Remove the top and bottom covers and the internal top covers from the power supply and instrument compartments.

c. Remove the air filter from the rear of the fan compartment. Clean the filter using either low pressure clean dry air or a water and mild detergent solution.

d. Clean the interior of the 5215A using low-pressure clean dry air or a vacuum cleaner.

e. If required, clean the PCB assemblies by spraying them with anhydrous ethyl alcohol to lossen the dirt and then removing all residue with low pressure clean dry air. Allow at least six hours for drying time before reapplying power to the 5215A.

f. Clean the front panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened with a mild solution of detergent and water.

4-9. Fuse Replacement

4-10. Listed below are the correct replacements for the Line Power Fuses. Use only the correct rating as a replacement, dependent upon the supply voltage:

a. Line voltage 100 or 115 volts:
High Voltage — MDA 15 amp
Aux Power — MDA 5 amp

b. Line voltage 200 or 230 volts:

High Voltage — MDA 8 amp
Aux Power — MDA 2 amp

4-11. Line Voltage Selection

4-12. The 5215A can operate from any one of four possible line voltages. Selection between 100, 115, 200, or 230 is performed by a combination of jumper positionings which may be changed locally if required. The jumpers may be set to the desired configuration using the procedure given in Section 2 under the heading of Input following procedure:

CAUTION!

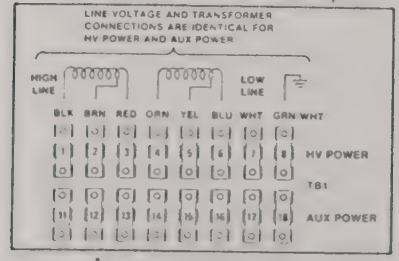
Lethal voltages of up to ±4000V are present within the instrument for up to 30 sec after power is removed from the system. Extreme caution should be exercised any time that the inner covers are removed from the instrument for servicing.

a. Verify that neither line cord is connected to a power source.

b. Remove the top dust cover and left inner cover from the instrument.

c. Locate the input power terminal strips shown in Figure 4-1. The layout is also shown on the transformer cover.

Figure 4-1. Input Power Terminal Strips


LINE VOLTAGE AND TRANSFORMER CONNECTIONS ARE IDENTICAL FOR HV POWER AND AUX POWER
HIGH LINE
LOW LINE
BLK BRN RED ORN YEL BLU WHT GRN WHT
HV POWER
TB1
AUX POWER

d. Connect the jumpers as shown in Figure 4-1 and Table 4-1.

Table 4-1. Input Line Voltage Jumper Connections

LINE VOLTAGE	JUMPER	HV POWER JUMPER	JUMPER
100	1 to 4	2 to 5	5 to 7
115	1 to 4	3 to 6	6 to 7
200	2 to 4	5 to 7	7 to 7
230	3 to 4	6 to 7	7 to 7
		AUX POWER	
100	11 to 14	12 to 15	15 to 17
115	11 to 14	13 to 16	16 to 17
200	12 to 14	15 to 17	17 to 17
230	13 to 14	16 to 17	17 to 17

e. Replace the inner dust cover.

f. Install 15 and 5 amp fuses if the 100 or 115 volt input line voltage has been selected or 8 and 2 amp fuses if the 200 or 230 volt input has been selected.

4-13. Lamp Replacement

4-14. The indicators on the 5215A consists of both incandescent lamps and Light Emitting Diodes (LEDs). If replacement is required, use the following procedures:

4-15. INCANDESCENT LAMP REPLACEMENT

a. Insure power is disconnected from the 5215A.

b. Remove the top cover.

c. The INSTRUMENT ON and OPERATE indicators are dual incandescent lamps mounted on individual plug-in assemblies. To remove, reach down in the space between the front panel and logic board and grasp the desired PCB and remove by pulling straight up.

d. Replace the defective lamp and reassemble the instrument in the reverse order.

4-16. LED REPLACEMENT

a. Insure power is disconnected from the 5215A.

b. Remove the POWER knob on the front panel from its shafts using a 0.050 allen type hex wrench.

c. Remove the top cover and the front three screws from the bottom cover.

d. Remove the five screws on each side from under the side decals that secure the front handles and front panel to the mainframe.

e. The front panel is now free to be moved away from the logic PCB for access to the LEDs.

f. Remove the LEDs requiring replacement from the extension sockets and replace.

g After replacement reassemble the 5215A in reverse order.

4-17. Access to the Mainframe PCB Assemblies

4-18. PRELIMINARY PROCEDURES

4-19. The following procedure should be performed prior to removing any PCB from the instrument.

a. Disconnect both line power cords from the line power source.

b. Extremely hazardous voltages are present within the instrument for up to 30 sec after removal of power. Wait for at least this period before continuing.

c. Remove the top outer cover from the instrument.

d. As a safety precaution, insure no stray voltages are present in the power supply, shorting TP501 to TP502, TP504 to TP506 and TP505 to TP506. These test points are on the power supply PCB and their locations are shown in Figure 4-2.

e. Proceed to the paragraph pertaining to the particular PCB to be removed.

4-20. POWER SUPPLY ASSEMBLY REMOVAL

a. Remove the transformer cover from the left side of the instrument.

b. Disconnect the Molex connections from the transformer and power wiring.

c. Grasp the plaxtic retainers and gently rock the PCB while moving it upward. Once free of the

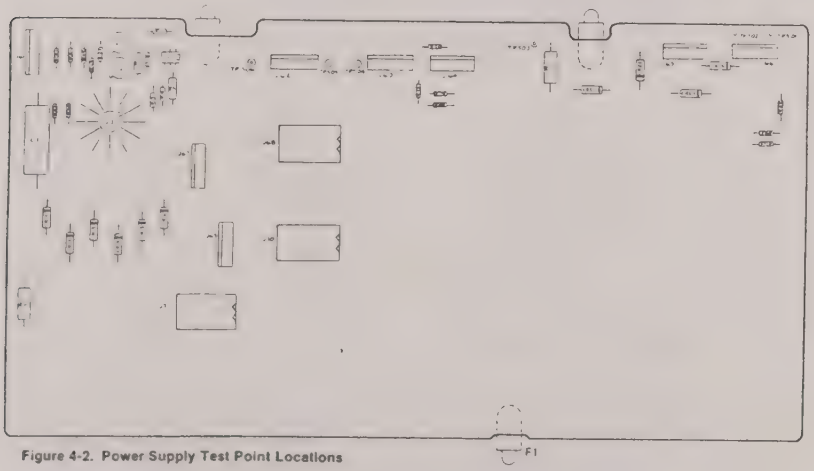


Figure 4-2. Power Supply Test Point Locations

Table 4-3 . Test Accessories

1500 pF capacitive load	Vitramon High Current porcelain capacitor, type VY84C152J (Fluke P/N 447383)
250 pF capacitive load	Vitramon High Current porcelain capacitor, type VY82C251J (Fluke P/N 447391)
100 pF capacitive load	Vitramon High Current porcelain capacitor, type VY81C101J (Fluke P/N 447409)
5000Ω resistive load	2 Resistors, Wire Wound, 10,000Ω ±5%, 225W Ohmite Type 0916 connected in parallel.
400Ω	2 Resistors, Wire Wound, 800Ω ±5%, 50W Ohmite Type 0404 connected in parallel.
RC Filter*	1 MΩ ±5%, ¼W carbon comp. resistor connected in series with a 1 uF ±10% 100V mylar capacitor.
Jumper PCBS (3 each)*	Used to maintain bias condition with low input line power during calibration. Three are provided with the instrument. Additional or replacement jumpers may be ordered using Fluke part number 400762 (Drawing 5205A-3080).
Insulated Trimming Tool*	Rated at 4 kV minimum — Recommended: JFD Adjustment tool 5284, Fluke P/N 153049
Adaptor — Banana Jack to BNC	UG 1094-U Provide Connection between 5200A output and 5205A local input
Coaxial Cable	Male BNC connector on each end — not to exceed 6 ft. in length
Jumper leads*	Standard leads with alligator clips on both ends for jumpering test points.
Thermal Transfer Standard to Thermoelement interconnect cable	Construct an interconnect cable using the listed materials or an equivalent: Connect pin 3 of Amphenol connector 91-MC3M to pin A of connector MS3106A10SL-4S using one lead of Belden type 8422 cable not exceeding 3 feet in length. Connect the second lead between pins 1 and B respectively of the connectors. Connect the cable shield to the shell of the MS3106A10SL-4S connector. Secure the cable using clamp MS3057-4A.

* Used during Calibration only.

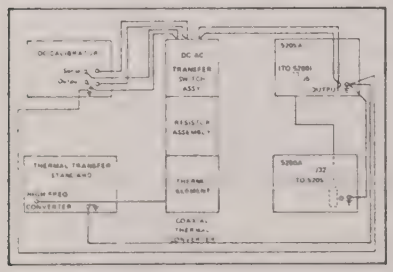


Figure 4-3. Calibrator Mode Connections

f. Using the thermal transfer method verify the 5215A output is equal to 1000V ac ±0.042%.

g Change the 5200A output frequency to 100 kHz on the 100 kHz range.

h. Using the thermal transfer method verify the 5215A output is equal to 1000V ac ±0.11%.

i. Set the 5200A MODE switch to STDBY and the Frequency output to 1 kHz.

j. Wait at least 30 seconds, then apply a 5 kΩ 100 pF parallel load to the 5215A output terminals.

k. Repeat steps e through i.

l. Wait at least 30 seconds, then apply a 1500 pF load to the 5215A output terminals.

m. Repeat steps e and f.

n. Set the 5200A MODE switch to STDBY.

o. Wait at least 30 seconds then remove the 1500 pF load and apply a 250 pF load.

p. Repeat steps e, g and h, omitting step f.

q. Set the 5200A MODE switch to STDBY. Wait at least 30 seconds then disconnect the thermal test equipment and the 250 pF load.

r. Connect an RMS differential voltmeter to the 5215A output termnals.

s. Set the 5200A controls for an output of 180V at 100 kHz.

t. Set the 5200A MODE switch to OPER and adjust the rms differential voltmeter for a null reading.

WARNING!

Observe all safety requirements before applying a load to an operating instrument. Do not come in physical contact with the load at any time.

u. Apply the 1500 pF load to the 5215A output, insuring the deviation from the null does not exceed ±1.05%.

v. Set the 5200A MODE switch to STDBY. Wait at least 30 seconds then remove the applied load and test equipment.

w. Terminate the 5215A output with the 250 pF load.

x. Set the 5200A controls for an output of 1100V at 105 kHz and the 5200A MODE switch to OPERATE.

y. If FAULT and or OVERLOAD occurs perform the 5215A calibration procedure.

z. Set the 5200A MODE swith to STDBY wait at least 30 seconds then remove the load. This completes the 5215A Performance Test.

4-32. CALIBRATION PROCEDURES

4-33. General

4-34. The 5215A Calibration procedure should be performed at least every 90 days or any time that a component is replaced. The recommended test equipment and accessories are listed in Tables 4-2 and 4-3. The internal layout is shown in Figure 4-4 while the test point and adjustment locations for the Power Amplifier, Preamplifier and Logic PCB are shown in Figures 4-5, 4-6, and 4-7 respectively.

4-35. Each main division in this procedure begins with a step verifying that all controls and test equipment is in the proper configuration prior to beginning the check. This added precaution is required because of the lethal voltages which can reach 4000 volts internally and 1500V on the output terminals. Since these extremely high voltages are present extra care should be taken to insure that conductive items, such as screwdrivers, pliers or fingers are not inserted into the instrument compartment. Care should also be taken to prevent foreign objects from falling into the instrument since they may decrease the voltage breakdown capability of the inner circuitry. When replacing the top cover or right side panel after adjustments check the inside of the instrument very carefully to insure there are no loose screws, pieces of solder or other objects left behind. Use only nonconductive trimming tools, rated at 4 kV minimum for any internal adjustments.

4-36. Oscilloscope Preparation

4-37. MAINFRAME AND PROBE CALIBRATION

4-38. Prior to beginning the 5215A Calibration check the DC zero level on the scope display. Also verify the calibration and AC response of the 100:1 and 10:1 probes when they are connected to the channel on which they are to be used.

4-39. CURRENT PROBE CALIBRATION

4-40. The Tektronix P6042 DC Current probe must be calibrated at zero current each time it is used. Use the following procedure to prepare the current probe for use each time it is connected to the scope mainframe.

a. Connect the P6042 output with a 50Ω BNC cable to the oscilloscope, using an HP-10100C 50Ω feed through resistor at the oscilloscope input.

b. Turn on the oscilloscope and current probe power and allow them to warmup for at least five minutes, preferably 30 minutes.

c. Set the oscilloscope controls as follows:
Volts/div—50 mV
Variable (Volts/div)—Calibrated
Input Coupling—Ground

d. Set the Current Probe controls as follows:
Output DC level—Midrange
Current/div Balance—Midrange
Current/div—1A

e. Center the trace vertically on the CRT, then switch the input coupling to DC.

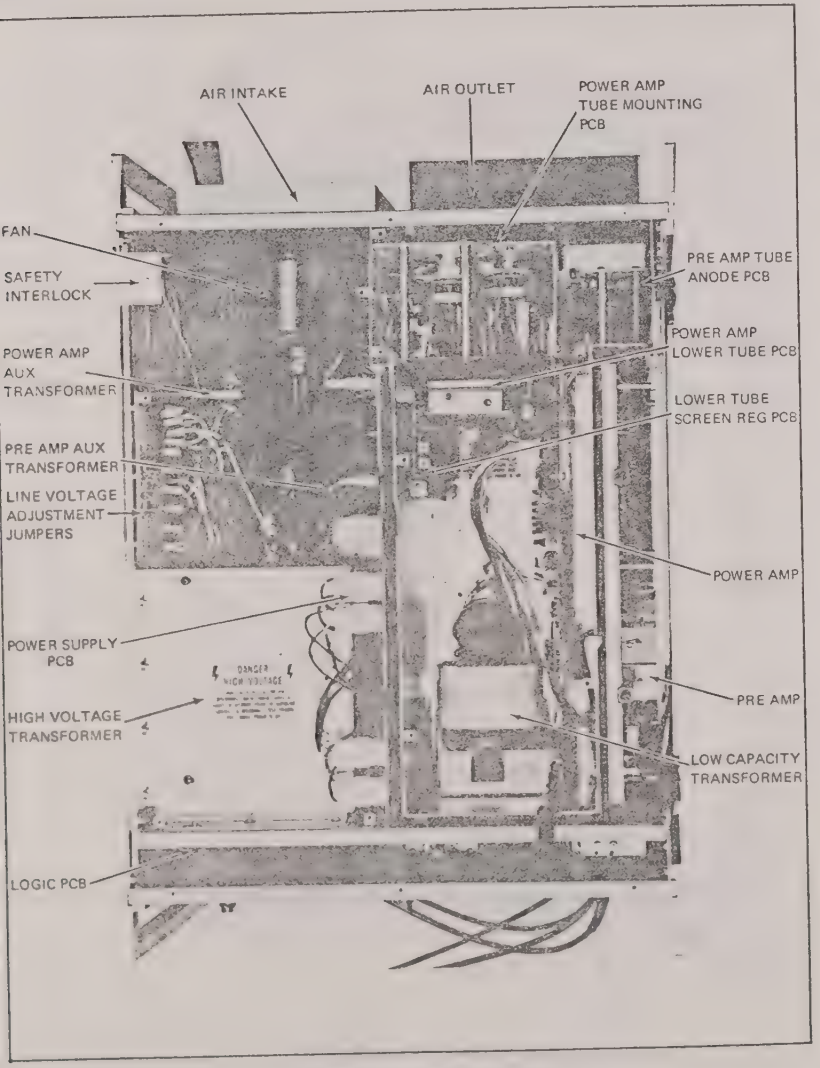


Figure 4-4. Internal Layout

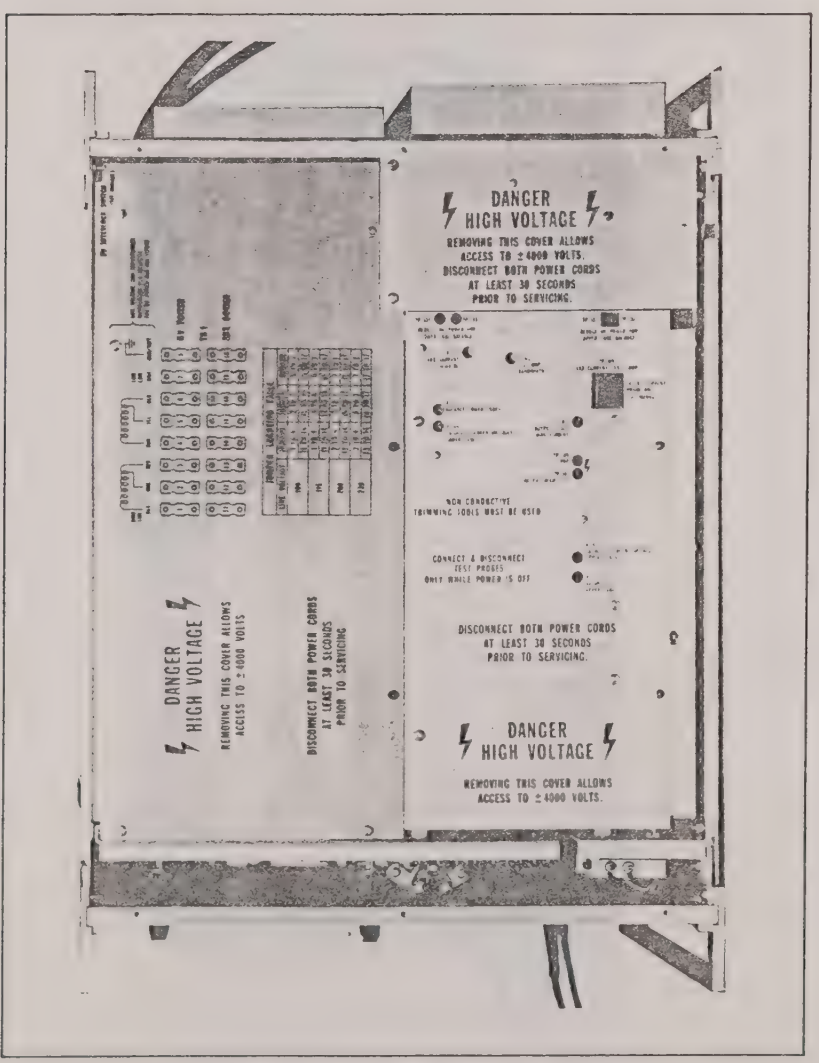


Figure 4-5. Power Amplifier Adjustment Ports

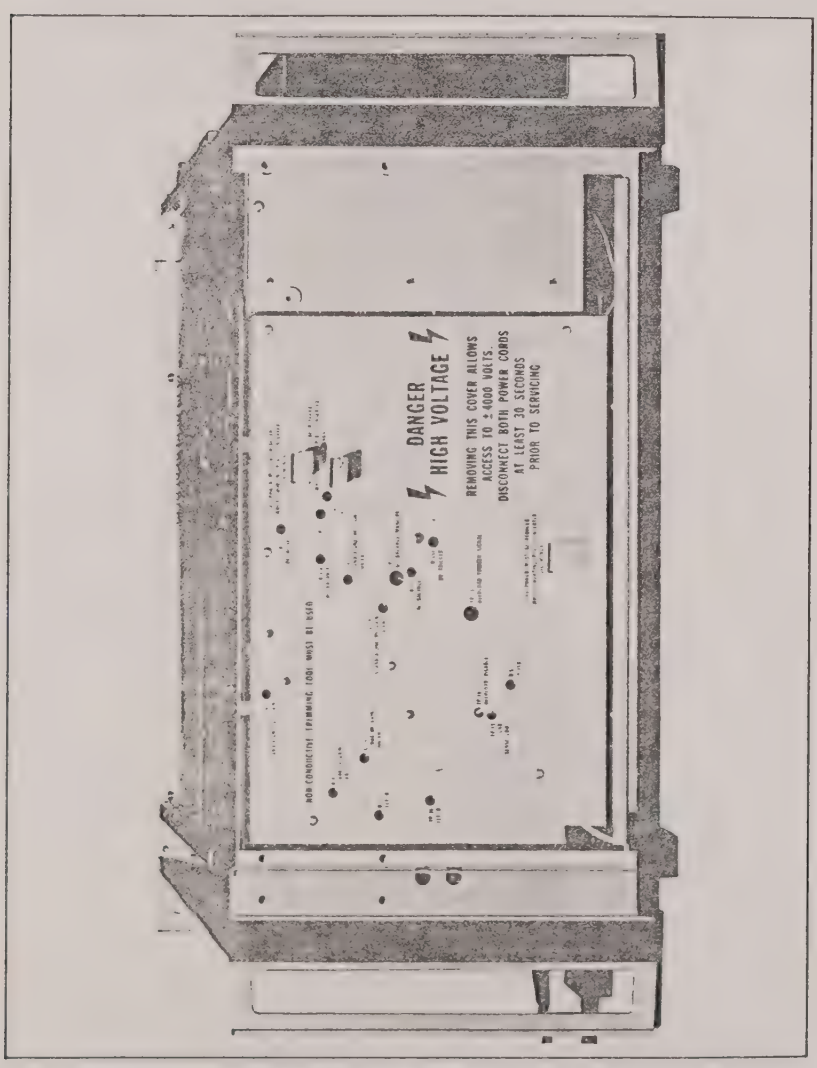


Figure 4-6. Preamplifier Adjustment Ports

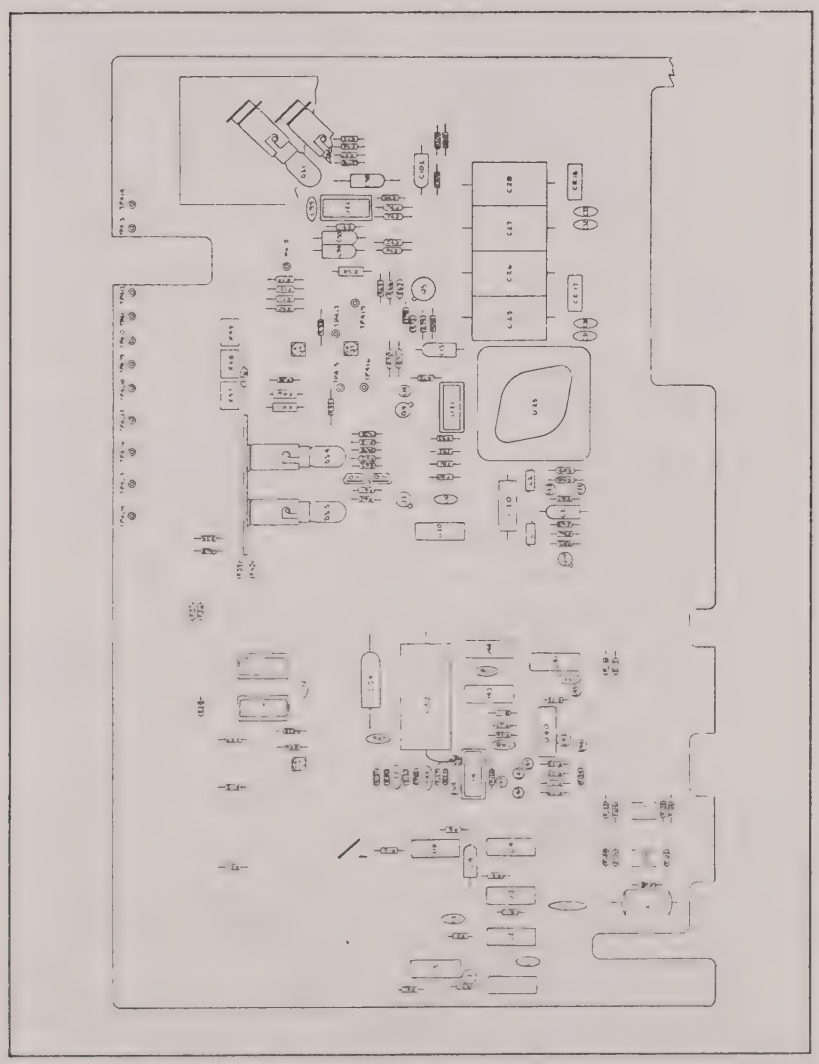


Figure 4-7. Logic PCB Test Point Location

f. Push the thumb-controlled portion of the probe into the locked position. When the slider is in the locked position the shield around the transformer core is grounded, the PROBE UNLOCKED light is extinguished and the amplifier is ready for operation.

g. Place the probe fully into the front-panel receptacle. Momentarily (200 ms minimum) depress the DEGAUSS lever and release.

h. Adjust OUTPUT DC LEVEL to center the trace vertically on the CRT.

i. Set the CURRENT DIV switch to the desired position (in most tests it is 10 mA/div) and again degauss the probe

j. Adjust CURRENT DIV BALANCE to center the trace vertically on the CRT.

k. Remove the probe from the front-panel receptacle, move the slider back, and place the probe around the conductor under test. Push the slider forward into the locked position. With the oscilloscope deflection factor set at 50 mV/div, the amplitude of the current waveform may be read directly from the front panel of the P6042.

NOTE

The current probe calibration procedure is necessary after initial turn-on and after making current measurements in excess of the dynamic range of the P6042. To degauss, lock the probe and place it in the panel receptacle and press the DEGAUSS lever.

4-41. Equipment Preparation

4-42. Prepare the instrument for calibration using the following procedure:

a. Insure both power cords are disconnected from the AC power line.

b. Connect the previously calibrated 5200A to the 5215A using the special interconnect cable (P N 341560) provided with the 5215A Accessory Pack.

c. Insure that the POWER switch on the 5215A front panel is OFF.

d. Set the 5200A front panel controls to the following positions:

POWER switch to ON. After the STDBY indicator illuminates, continue.
MODE switch to STDBY
CONTROL switch to LOCAL
PHASE LOCK switch to OFF
SENSE switch to INT
VOLTAGE ERROR switch to OFF
VOLTAGE RANGE at 1000V
FREQUENCY RANGE at 100 kHz
VOLTAGE MAGNITUDE at 100V
FREQUENCY MAGNITUDE of 100 kHz

e. Remove the top cover of the instrument.

f. Remove the right side cover to expose the preamplifier adjustments by removing the seven holding screws and pulling the side cover straight up.

g. Using the shorting link provided insure the OUTPUT LOW and chassis ground terminals are connected and firmly in place (on front panel).

h. Disable the HV interlock by pulling the center rod of the interlock switch up. The interlock switch is located in the left rear corner of the instrument protruding through the transformer compartment cover.

i. Set the autotransformer for zero output.

j. Connect the autotransformer input to the nominal AC line voltage for which the instrument is rated. (Be sure variac is rated for the line voltage and current being used.)

CAUTION!

All test points and adjustments on the preamplifier are accessible through openings in the shields covering the instrument compartments. Do not remove these shields during the calibration procedure. Always be sure to use a non-conductive screwdriver rated to 4 kV to make these adjustments.

4-43. Output Stage Calibration

4-44. A portion of the calibration procedure contained in the following subparagraph is performed with the high voltage line power supply input reduced to 25% of nominal. This reduces the high voltages present in the instrument to approximately 600 volts. The bias states are properly maintained in this condition with a jumper system. This feature lessens the danger associated with calibrating or servicing a potentially lethal instrument. All line power input voltages are given as a percentage of

the nominal line voltage for which the instrument is wired.

4-45. The balance readings are or may be at a high potential. The reading should be taken with a floating DVM, that is, a battery operated meter with no connection to ground through the line cord, to reduce common mode measurement errors. Care should be taken that the DVM chassis is well separated from any conducting material to prevent voltage breakdown.

WARNING!

Do not touch the DVM when the 5215A power is on.

4-46. When the three jumper PCB's are required to maintain bias during operation with less than normal input voltage, insert them in the marked slots in the preamplifier shield.

4-47. Personnel performing the calibration procedure should be aware of the hazardous voltages present and observe good safety precautions at all times.

4-48. OUTPUT STAGE INITIAL SET-UP

4-49. Connect a 100:1 probe to the Oscilloscope input channel. Prepare the oscilloscope to read 5 mV per division (corresponding to 0.5V per division at the probe tip) using DC coupling. Connect the probe to TP307 OUTPUT HIGH TEST through the Power Amp shield. Connect the scope ground lead to chassis.

4-50. Battery Operated DVM: Prepare the DVM to read less than 2V dc. Connect the HI input lead to TP331 and the LO lead to TP332 through the Power Amp shield.

CAUTION!

Insure the floating DVM case is well away from all conductive material to prevent short circuits. Although the procedure is safe when performed as described, under extremely abusive conditions a hazardous situation might occur. Verify the probe leads are properly insulated to preclude any shorts or arching to the Power amp shield or chassis.

4-51. Autotransformer: Set the output to zero volts and connect the power line cord to the nominal line voltage.

4-52. 5215A: Insure the equipment preparation procedure in paragraph 4-41 is complete. Install the three jumper PCBs through the Preamplifier shield. Connect the Auxiliary Power line cord to the nominal line voltage and the High Voltage line cord to the autotransformer.

4-53. UPPER TUBE BALANCE

WARNING!

Do not touch the DVM with hands or body any time that power is applied to the 5215A.

4-54. Perform the calibration using the following procedure.

a. Insure the autotransformer output is set on zero.

b. Set the 5215A POWER switch to ON.

NOTE

The INSTRUMENT ON and WARMUP indicators illuminate. After a 30 second delay the WARMUP indicator extinguishes. This time delay occurs each time power is applied to the instrument after it has been removed. If the instrument is set to OPERATE before the time delay expires a FAULT indication results.

c. After the warmup period raise the autotransformer output voltage to approximately 25% of nominal line voltage (25% x 115V = 29V).

d. Verify the voltage displayed on the oscilloscope is ± 100 mV at the probe tip (less than ±0.2 division on the display). If the display is greater than ±100 mV the circuit is defective.

NOTE

The above reading is adjusted during the DC OFFSET CALIBRATION later in this procedure. If it exceeds the listed tolerance it is beyond the adjustment range and should be repaired at this time. Use the Troubleshooting procedure in Table 4-3 starting at step 86.

e. Adjust R33 BALANCE UPPER TUBES for a minimum reading on the DVM. The maximum allowable reading is 0 ±10 mV dc.

f. If the reading exceeds the allowable, remove power, set R35 ABSOLUTE SCREEN VOLTAGES UPPER TUBES to approximately mid-range, reapply power, then repeat the test. If the reading still exceeds the allowable, the instrument is defective.

g. Set the autotransformer output voltage to zero, set the POWER switch to OFF and disconnect both power cords. Wait at least 30 seconds for the Power Supply to discharge and disconnect the DVM from test points 331 and 332.

4-55. LOWER TUBE BALANCE

4-56. Make the following equipment changes:

a. Connect the Battery Operated DVM Hi input lead to TP333 and the LO lead to TP 334 through the Power Amp shield.

CAUTION!

Insure the floating DVM case is well away from any conductive material to prevent short circuits. Although the procedure is safe when performed as described, under extremely abusive conditions a hazardous situation might occur. Verify the probe leads are properly insulated to preclude any shorts or arcing to the Power amp shield or chassis.

b Reconnect the Auxiliary Power line cord to the nominal line voltage and the High Voltage line cord to the autotransformer.

WARNING!

Do not touch the DVM with hands or body at the time that power is applied to the 5215A.

4-57 Perform the calibration using the following procedure:

a. Insure the autotransformer output is set to zero

b Set the 5215A POWER switch to ON

c. After the Warmup period raise the autotransformer output voltage to approximately 25% of the nominal line voltage (25% x 115V = 29V).

d Verify the voltage displayed on the oscilloscope 0 ±100 mV dc at the probe tip (less than ±0.2 division on the display). If greater than ±100 mV the instrument is defective.

NOTE

The above reading is adjusted during the DC OFFSET CALIBRATION later in this procedure. If it exceeds the listed tolerance it is beyond the adjustment range and should be repaired at this time. Use the troubleshooting procedure in Table 4-4 starting at step 86.

e. Adjust R112 BALANCE LOWER TUBES for a minimum reading on the DVM. The maximum allowable reading is 0 ±10 mV dc.

f. If the reading exceeds the allowable, remove power, set R109 ABSOLUTE SCREEN VOLTAGES LOWER TUBES to approximately mid-range, reapply power, then repeat the test. If the reading still exceeds the allowable the instrument is defective.

g. Set the autotransformer output voltage to zero, set the POWER switch to OFF and disconnect both power cords. Wait at least 30 seconds for the Power Supply to discharge and disconnect the DVM from test points 333 and 334.

4-58. OUTPUT STAGE BIAS CURRENT

4-59. Make the following equipment changes:

a. Connect the Battery Operated DVM HI input lead to TP307 OUTPUT HIGH TEST and the LO lead to TP308 PNP through the Power Amp shield. Both the DVM and Scope HI input leads are now connected to this test point.

CAUTION!

Insure the floating DVM case is well away from any conductive material to prevent short circuits. Although the procedure is safe when performed as described, under extremely abusive conditions a hazardous situation might occur. Verify the probe leads are properly insulated to preclude any shorts or arcing to the Power amp shield or chassis.

b. Reconnect the Auxiliary Power line cord to the nominal line voltage and the High Voltage line cord to the autotransformer.

WARNING!

Do not touch the DVM with hands or body any time that power is applied to the 5215A.

4-60. Perform the calibration using the following procedure.

a Insure the autotransformer output is set to zero.

b. Set the 5215A POWER switch to ON.

c. After the Warmup period raise the autotransformer output voltage to approximately 25 % of the nominal line voltage (25% x 115V = 29V).

d. Verify the voltage displayed on the oscilloscope is 0 ±100 mV dc at the probe tip (less than ±0.2 division on the display). If the display is greater than ±100 mV the circuit is defective.

NOTE

The above reading is adjusted during the DC OFFSET CALIBRATION later in this procedure. If it exceeds the listed tolerance it is beyond the adjustment range and should be repaired at this time. Use the Troubleshooting procedure in Table 4-4 starting at step 86.

e Adjust R7 OUTPUT STAGE BIAS CURRENT for a reading between +220 mV and +240 mV on the DVM.

f. Set the autotransformer output voltage to zero, set the POWER switch to OFF and disconnect both power cords. Wait at least 30 seconds for the Power Supply to discharge and disconnect the DVM from test points 307 and 308.

4-61. LED LOOP BIAS CURRENT

4-62. Make the following equipment changes:

a Insure the P6042 current probe is calibrated for a zero indication and a current sensitivity of 10 mA/division as described in the Current Probe Calibration procedure.

b Connect the current probe around TP309 LED CURREN TEST LOOP with the arrow on the probe pointing to the front of the instrument. Also insure the probe is properly locked and the PROBE UNLOCKED indicator is extinguished as described in the Current Probe Calibration.

c. Set the oscilloscope current channel controls for DC coupling with sensitivity of 50 mV/division.

d. Reconnect the Auxiliary Power line cord to the nominal line voltage and the High Voltage line cord to the autotransformer.

4-63. Perform the calibration using the following procedure:

a. Insure the autotransformer output is set to zero.

b. Set the 5215A POWER switch to ON.

c. After the Warmup period raise the autotransformer output voltage to approximately 25% of the nominal line voltage (25% x 115V = 29V).

d Verify the voltage displayed on the oscilloscope is 0 ±100 mV dc at the probe tip (less than ±0.2 division on the display). If greater than ±100 mV the instrument is defective.

NOTE

The above reading is adjusted during the DC OFFSET CALIBRATION later in this procedure. If it exceeds the listed tolerance it is beyond the adjustment range and should be repaired at this time. Use the troubleshooting procedure in Table 4-4 starting at step 86.

e. Display the LED Current and carefully adjust R172 LED CURRENT for a display of -30 mA ±1 mA (3 div ±0.1 div).

f. Lower the autotransformer voltage to zero, dropping the LED Current to zero, and verify the current probe zero adjustment.

g. Raise the autotransformer output voltage back to the previous setting of approximately 25% of the nominal line voltage.

h. Verify the LED current is -30 mA ±1 mA. Readjust R172 if required.

i. Set the autotransformer output to zero. Set the POWER switch to OFF and disconnect both Power cords. Wait at least 30 seconds for the Power Supply to discharge then disconnect the voltage and current probes and the three jumper PCB's from the instrument.

4-64. LED LOOP BANDWIDTH

4-65. Make the following equipment changes:

a. Set the Oscilloscope current channel controls for AC Coupling remaining at 50 mV/division sensitivity, then center the trace baseline.

b. Connect the 100:1 probe across the 5215A output terminals. Set the scope controls for DC coupling, 0.5V/division sensitivity (corresponding to 50V at the probe tip) and a Time Base of 2 used/division.

c Verify removal of the three jumper PCB from the preamplifier.

d. Disable the ±200 mA current trips on the 5215A Logic PCBs by connecting TP410 (IL+)to TP409 (+5V) with a jumper to disable the positive HV supply current trip and TP408 (IL-) to TP407 (GND) to disable the negative HV supply current trip.

e. Connect the 400Ω 100W load resistor across the 5215A output terminals.

(

f. Reconnect the Auxiliary Power line cord to the nominal line voltage and the High Voltage line cord to the autotransformer.

4-66. Perform the calibration using the following procedure:

a. Insure the autotransformer output is set to zero.

b. Set the 5200 magnitude for an output of 113.2V at 100 kHz.

c. Set the 5215A POWER switch to ON.

d. After the Warmup period quickly raise the autotransformer output voltage to 100% of the nominal line voltage.

NOTE

OVERLOAD and FAULT indications will result if the autotransformer output is raised too slowly.

e Set the 5200A MODE switch to OPERATE.

f The scope voltage channel probe displays a 6.4 division peak-to-peak sinusoidal waveform, corresponding to approximately 800 mA p-p output current. Since the gain has not yet been set the magnitude of the display will not be exact.

g. Adjust C162 LED LOOP BANDWIDTH so that the current channel waveform is 30 mA p-p between the positive and negative peaks. The waveform should appear as shown in Figure 4-8.

Figure 4-8. LED Loop Current Waveform

NOTE

The current displayed is essentially proportional to the derivative of the total current drawn by the Power Amplifier lower Output tubes.

h. Set the 5200A MODE switch to STDBY. Set the POWER switch to OFF and disconnect both power cords. Wait at least 30 seconds for the Power Supply to discharge and disconnect the oscilloscope voltage and current probes from the instrument.

4-67. SCREEN VOLTAGE CALIBRATION

4-68. Make the following equipment changes:

a. Prepare the DVM to monitor the nominal AC line voltage and connect the input leads across the autotransformer output.

b Prepare the oscilloscope for operation with sensitivity of 0.5V/division (corresponding to 50V/division at the probe tip), a time base of 20 usec/division and dc coupling.

c. Accurately adjust the oscilloscope probe AC compensation using the oscilloscope calibrator.

d Set the vertical gain of the oscilloscope by applying 226.28V rms 10 kHz from the 5215A output to the 100:1 input probe. Adjust the scope channel variable gain for a display of exactly 8 divisions peak-to-peak.

e. Disable the 5215A overload circuits by connecting TP18 OVERLOAD DISABLE to TP19 GND (SENSE LOW) with a jumper. The test points can be reached through the Preamplifier shield.

f. Reconnect the Auxiliary Power line cord to the nominal line voltage and the High Voltage line cord to the autotransformer.

4-69. Perform the calibration using the following procedure:

NOTE

For correct adjustment of the current limits it is important to check the zero baseline for drift both before and after the procedure. If any drift occurs the procedure should be repeated.

a Raise the autotransformer output voltage to nominal plus 10% (110% x 115V = 126.5V).

b Set the 5200A for an output of 180V rms at 10 kHz.

c Set the 5215A POWER switch to ON.

NOTE

The 5215A internal power dissipation is very high when it is in the OPERATE mode. Maintain this status only as long as necessary to make the required adjustment.

d. After the warmup period, set the 5200A MODE switch to OPERATE.

e. Adjust R109 ABSOLUTE SCREEN VOLTAGES LOWER TUBES through the power amplifier shield until the scope displays a waveform where the flat portion of the negative peak is at exactly -240 volts (-3.0 divisions).

f. Check the zero baseline, setting the 5200A MODE switch to STDBY and then back to OPERATE. The adjusted peak voltage should remain as set in Step e above.

g. Set the 5200A output voltage magnitude to 156V rms.

h. Adjust R35 ABSOLUTE SCREEN VOLTAGES UPPER TUBES through the power Amplifier shield until the scope displays a waveform where the flat portion of the positive peak is at exactly +208 volts (+2.6 divisions).

i Check the zero baseline by setting the 5200A MODE switch to STDBY and then back to OPERATE. The adjusted peak voltage should remain as set in Step h above.

j. Set the 5200A MODE switch to STDBY and the POWER switch to OFF. Set the autotransformer output voltage to zero and disconnect both power cords. Remove the oscilloscope and DVM leads.

4-70 POSITIVE CURRENT TRIP LEVEL ADJUSTMENT

4-71. Make the following equipment changes:

a Insure a jumper connects TP408 (IL-) and TP407 (GND) on the Logic PCB. Remove the other jumpers previously installed between test points on the Logic and Preamplifier PCB's. The jumper remaining disables the negative current trip while sitting the positive trip level.

b Connect the DVM HI input leat to TP411 (I+) and the LO lead to TP407 (GRND) on the Logic PCB. Prepare the DVM to read less than 2V dc.

c Reconnect the Auxiliary Power line cord to the nominal line voltage and the High Voltage line cord to the autotransformer.

4-72. Perform the calibration as follows:

a. Insure the autotransformer output is set to zero.

b. Set the 5215A POWER switch to ON.

c After the warmup period, raise the autotransformer output voltage to the nominal line voltage.

d. Set the 5200A magnitude to 114 Volts rms at 100 kHz.

e. Set the 5200A MODE switch to OPERATE.

f Observe the DVM reading and slowly increase the 5200A output until the 5215A trips into FAULT and drops out of OPERATE.

g. The DVM should read between -210 and -214 mV when it trips. If the DVM reading is within tolerance set the 5200A MODE switch to STDBY, the 5215A POWER switch to OFF, the Autotransformer output to zero and then proceed to the Negative Current Trip Level Adjustment in the following paragraph. If the reading is not acceptable continue with Step h of this paragraph.

h. Reduce the 5200A voltage magnitude to a level less than 114V to prevent a FAULT condition.

i. Rotate R49 fully counterclockwise.

j. Set the 5200A MODE switch to STDBY and then OPERATE.

k. Adjust the 5200A voltage magnitude for a reading on the DVM between -211 and -213 mV.

l. Very slowly rotate R49 clockwise until the 5215A trips into FAULT and drops out of OPERATE.

m Decrease the output level of the 5200A slightly and reset the FAULT on the 5215A by setting the 5200A MODE switch first to STDBY and then to OPERATE.

n Slowly increase the 5200A voltage magnitude until the 5215A trips into FAULT, verifying that it occurs between -210 and -214 mV.

o Set the 5200A MODE switch to STDBY and the 5215A POWER switch to OFF. Set the autotransformer output voltage to zero.

4-73 NEGATIVE CURRENT TRIP LEVEL ADJUSTMENT

4-74 Make the following equipment changes:

a Reduce the 5200A voltage magnitude to 114V rms, remaining at 100 kHz.

b Remove the jumper between TP407 and TP408 and connect it between TP410 (IL-) and TP409 (+5V) to disable the Positive current trip while setting the negative trip level.

c. Transfer the DVM HI input lead to TP412 (I-) on the Logic PCB.

4-75. Perform the calibration as follows:

a. Set the 5215A POWER switch to ON.

b. After the warmup period, raise the autotransformer output voltage to the nominal line voltage.

c. Set the 5200A MODE switch to OPERATE.

d. Observe the DVM reading and slowly increase the 5200A voltage magnitude until the 5215A trips into FAULT.

e The DVM should read between +210 and +214 mV when it trips. If the DVM reading is within tolerance proceed to the following paragraph. If the reading is not acceptable continue with Step f of this paragraph.

f. Reduce the 5200A voltage magnitude to less than 114V to prevent a FAULT condition.

g Rotate R48 fully counterclockwise.

h Set the 5200A MODE switch to STDBY then OPERATE.

i. Adjust the 5200A voltage magnitude for a reading on the DVM between +211 and +213 mV.

j Very slowly rotate R48 clockwise until the 5215A trips into FAULT and drops out of OPERATE.

k Decrease the output level of the 5200A voltage magnitude just slightly and reset the FAULT on the 5215A by setting the 5200A MODE switch first to STDBY and then to OPERATE.

l Slowly increase the 5200A voltage magnitude until the 5215A trips into FAULT, verifying that it occurs between +210 and +214 mV.

4-76. The Output stage portion of the Calibration is complete. Set the 5200A MODE switch to STDBY and the 5215A POWER switch to OFF. Set the autotransformer output voltage to zero. Remove any jumpers installed in the instrument. Disconnect both power cords. Wait at least 30 seconds for the power supply to discharge then disconnect the DVM and the Output load from the instrument.

4-77. Preamplifier Calibration

4-78. This portion of the procedure contains the information necessary to calibrate the preamplifier section of the 5215A. As in the output stage calibration, all adjustments should be made through the indicated ports in the preamplifier shield. The shield should not be removed at any time since voltages up to 4000V are present within the instrument any time power is applied. Insert the output cable terminal into its safety area any time it is not in use. No jumpers or jumper PCBs are used during this test and should be removed if installed. The shorting link between the front panel OUTPUT LOW and Chassis ground terminals should be installed at all times.

4-79. PREAMPLIFIER INITIAL SET-UP

4-80. DVM: Prepare the DVM to read less than 20V dc. Connect the HI input lead to TP11 +15V and the LO lead to TP19 GND (SENSE LOW).

4-81. Autotransformer: Set the output to zero volts and connect the power line cord to the nominal line voltage.

4-82. 5215A: Insure the equipment preparation procedure in paragraph 4-41 is complete, the 5200A is connected with the interconnect cable supplied and all jumper wires or PCBs are removed from the instrument. Connect the Auxiliary Power line cord to the nominal line voltage.

4-83. PREAMPLIFIER ±15 VOLT SUPPLY VOLTAGE

4-84. Perform the calibration as follows:

a. Set the 5215A POWER switch to ON.

b. Adjust R82 +15V for a reading on the DVM between +14.95 and 15.05 volts.

c. Move the DVM HI input lead to TP12 -15V.

d. The DVM reads between -14.65 and -15.35 volts. There is no adjustment.

e. Set the 5215A POWER switch to OFF.

f. Remove the DVM test leads.

4-85. MINIMUM NEGATIVE HIGH VOLTAGE TRIGGER LEVEL

4-86. Make the following equipment changes:

a. Prepare the DVM to monitor the nominal line voltage and connect the input leads across the autotransformer output.

b. Set the 5200A ontrols for an output of 110V on the 1000V range at 1 kHz.

c Connect the High Voltage line cord to the autotransformer.

4-87. Perform the calibration as follows:

a Insure the autotransformer is set to zero.

b. Set the 5215A POWER switch to ON.

c After the Warmup period raise the autotransformer output voltage to the nominal line voltage.

d Set the 5200A MODE switch to OPERATE.

e Observe the DVM reading and slowly decrease the autotransformer output until the 5215A trips into FAULT and drops out of OPERATE.

f The DVM should read between 98.0 and 98.6V ac at the trip point.

g Set the 5200A MODE switch to STDBY, the 5215A POWER switch to OFF and the autotransformer output to zero.

h If the DVM reading is within tolerance proceed to the Input FET switch Impedance Calibration in the next paragraphs. If the reading is not acceptable continue with the procedure in Step i of this paragraph.

i. Rotate R154 HV TRIGGER fully counterclockwise.

j Set the 5215A POWER switch ON.

k After the warmup period, raise the autotransformer output voltage to the nominal line voltage less 14.5% (115V -[115 x 14.5%] = 98.3V).

l Set the 5200A MODE switch to OPERATE.

m Slowly rotate R154 clockwise until the 5215A trips into FAULT and drops out of OPERATE.

n. Raise the autotransformer output voltage to the nominal line voltage.

o. Reset the FAULT on the 5215A by setting the 5200A MODE switch first to STDBY and then to OPERATE. The OPERATE indicator illuminates without a FAULT resulting.

p. Set the 5200A MODE switch to STDBY and the 5215A POWER switch to OFF. Lower the autotransformer output voltage to zero. Disconnect the DVM test leads from the autotransformer output.

4-88. OVERLOAD TRIGGER BALANCE CALIBRATION

4-89. Make the following equipment changes:

a. Connect a 10:1 probe to the oscilloscope input channel. Prepare the oscilloscope to read 5 mV/division (corresponding to 50 mV/division at the probe tip) using dc coupling. Connect the probe to TP1 DC BALANCE MONITOR through the preamplifier shield. Connect the scope ground lead to TP19 GND (SENSE LOW).

4-90. Perform the calibration as follows:

a. Insure the autotransformer is set to zero.

b. Set the 5215A POWER switch to ON.

c. After the warmup period, raise the autotransformer voltage to the nominal line voltage.

d. Ground oscilloscope input channel and set the trace to the middle of the CRT.

e. Remove the ground and adjust R130 DC BALANCE for a minimum display on the CRT, not to exceed 0 ±5 mV.

f. Set the 5200A controls for an output of 1100V rms at 110 kHz.

g. Select AC Coupling on the oscilloscope and move the probe to TP13 OVERLOAD TRIGGER SIGNAL.

WARNING!

Verify the output connector is stored in its safety area in the Front Panel. Dangerous voltages are present at the output terminals during this adjustment.

h. Set the 5200A MODE switch to OPERATE.

i. Adjust R111 AC BALANCE for a minimum peak-to-peak amplitude as displayed on the CRT.

j. Set the 5200A MODE switch to STDBY and the 5215A POWER switch to OFF. Lower the autotransformer output voltage to zero. Remove the oscilloscope probe from the instrument.

4-91. Calibration Point Adjustments

4-92. This section of the Calibration Procedure contains the steps required to set the calibration points. It is assumed that calibration of the output stage and preamplifier have already been completed.

4-93. When this portion of the procedure is performed, it should be done in conjunction with the 5200A with which the 5215A is normally used. Also, the 5200 should be calibrated immediately preceding the 5215A.

NOTE

If the 5215A is calibrated with one 5200A and used with a different 5200A, it is possible it will not meet specifications.

4-94. Steps in the following procedure must be performed in sequence. If a readjustment of any previous step is required, the entire procedure should be repeated, starting at the beginning. During the procedure the jumper PCBs are not installed and no jumpers between test points used. Also, the autotransformer is not used, both power cords are applied directly to line power.

4-95. DC OFFSET

4-96. Prepare the equipment for the test as follows:

a. Insure the 5215A POWER switch is ON and the shorting link connecting the front panel OUTPUT LOW and chassis ground terminals is installed and firmly in place.

b. Verify the 5200A controls are set for an output of 100V on the 1000V range at 100 kHz.

NOTE

The 5215A should have power applied continuously for at least one hour prior to beginning the following procedures.

c. Prepare the test DVM to read DC volts on its most sensitive scale, i.e., a resolution of at least 100 uV.

d. Connect the equipment as shown in Figure 4-9.

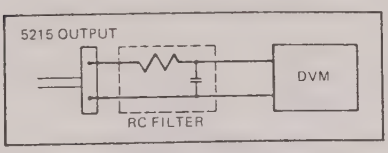


Figure 4-9. DC Offset Test Connections

4-97. Perform the calibration as follows:

a. Verify the one hour minimum warmup period for stability has elapsed.

b. Set the 5200A MODE switch to OPERATE.

c. Adjust R123 DC OFFSET for an output voltage of 0 ±1 mV.

d. Set the 5200A MODE switch to STDBY.

4-98. LOW AND HIGH FREQUENCY GAIN ADJUSTMENT

4-99. Prepare the equipment for the test as follows:

a. Connect the equipment as shown in Figure 4-3.

b. Set the 5200A controls for an output of 1000V rms at 1 kHz.

4-100. Use the following procedure to calibrate the low and high frequencies gain.

a. Set the 5200A MODE switch to OPERATE.

b. Perform the transfer test, adjusting R9 5200A LF GAIN (1 kHz) for a transfer standard null at 0 ±0.01% taking the correction factor into account.

c. Remaining in the 1000 Volt range set the 5200A output frequency to 100 kHz.

d. Perform the transfer test, adjusting C14 5200A HF GAIN (100 kHz) for a transfer standard null at 0 ±0.01% taking the correction factor into account.

e. Set the 5200 A MODE switch to STDBY.

f. Set the 5200A and 5200A POWER switches to OFF and disconnect the test equipment.

4-101. Interconnect Cable

4-102. An interconnect cable for use during the calibrator mode is supplied with each 5215A. The cable connects J32 on the rear of the 5200A to the connector labeled 5200A on the rear of the 5215A. A diagram of the pin connections is shown in Figure 4-10.

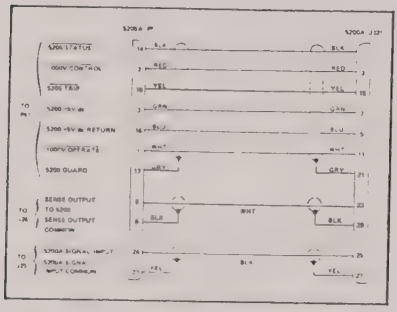


Figure 4-10. Calibrator Mode Interconnections

4-103. Logic Trip Adjustment

NOTE

This setting monitors the logic supply voltage and is adjusted at the factory. It should not require normal calibration, however, adjustment could be required if drift within the circuit is sufficient to trip the instrument into FAULT.

4-104. If required, adjust the logic trip circuit using the following procedure:

a. Verify that there are no jumper PCBs or jumpers installed in the 5215A and both power cords are connected to the line source.

b. Connect the DVM HI input to TP409 (+5) and the LOW input to TP407 (GND). Prepare the DVM to read +5V dc. Both test points are located on the logic PCB.

c. Connect a jumper between TP418 and TP417. (Located near the FAULT and OVERLOAD indicators on the Logic PCB.)

d. Set the POWER switch to ON and wait 30 sec for the warmup period to expire.

e. The DVM should read between 4.75 and 5.25 Volts dc.

f. Rotate R47 fully clockwise and then very slowly adjust until the fault indicator extinguishes.

g. Check at high and low line voltage limits (nominal ±10%) and the Logic circuits +5V is between +4.75 and +5.25V dc and the instrument does not trip into FAULT.

h. Set the POWER switch to OFF and disconnect the test equipment and jumper.

4-105. TROUBLESHOOTING

4-106. Troubleshooting for the 5215A consists of the tabular flow chart in Table 4-4. When a step on the flow chart is completed check for a decision transfer. If no decision is required perform the next step of the table in sequence.

WARNING

Lethal voltages up to 2.5 kV are present within the instrument during troubleshooting. In addition, the voltage may be present for up to 30 seconds after power is removed from the instrument. Before coming into physical contact with any component use a voltmeter and 5 kV probe to insure there is no voltage present between TP502 (−2.5 kV) and TP503 (LO), between TP504 (-2.5 kV) and TP506 (LO), and between TP505 (-2.5 kV) and TP506 (LO). All test points are on the Power Supply PCB. Extreme caution should be exercised at all times when working with this instrument.

Table 4-4. Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Prepare the 5215A for troubleshooting by performing Equipment Preparation in paragraph 4-41. In addition remove the Preamplifier and Power Amplifier shields, then connect the Auxiliary Power line cord only to the line voltage supply. Do not connect the HV Power Line cord to a supply at this time.		
2	Verify the Front Panel LOW and Ground terminals are connected with a shorting link and the POWER switch is in the OFF position.		
3	Set the POWER switch to the ON position.		
4	With the test DVM LO connected to TP22 on the Preamp check for +15 ±0.1V dc adjustable with R82 at tp11 and for −15 ±0.4V dc at tp12.		
5	Are both voltages within tolerance?	7	6
6	Check the 31V rms input from the Auxiliary Power Supply. Check the rectifier CR70, the applicable filter, series pass transistor, divider and the regulator circuit. Repair as required then repeat the test starting at step 4.		
7	With the test DVM LO input at tp9 of the Preamplifier check for +25 ±1V dc at tp10.		
8	Is the reading within tolerance?	10	9
9	Check the 21V rms input from the auxiliary power supply, the rectifier CR175 and its associated components. Repair as required then repeat the test starting at step 7.		
10	With the test DVM LO input at tp7 of the Preamplifier check for −31 ±1V dc at tp17 and +30 5 ±1V dc at tp8.		
11	Are both readings within tolerance?	13	12
12	Check the 40V rms input from the auxiliary power supply, the rectifier CR182 and its associated components. Repair as required then repeat the test starting at step 10.		
13	With the test DVM LO input at tp315 of the Power Amplifier check for +450 ±5V dc at tp325, −25 ±0.5V dc at tp321 and +24 ±0.5V dc at tp 322.		
14	Are all three voltages within tolerance?	16	15
15	Check the 171V rms and 38V rms inputs from the auxiliary power supply. Check the rectifiers and their associated components. Repair as required then repeat the test starting at step 13.		
16	With the test DVM LO input at tp303 of the Power Amplifier check for +440 ±5V dc at tp304 and +14.5 ±0.2V dc at tp 305.		

Table 4-4. Troubleshooting (Cont.)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
17	Are both voltages within tolerance?	19	18
18	Check the 171V rms and 12V rms inputs from the Auxiliary Power Supply. Check the rectifier circuits and their associated components. Repair as required then repeat the test starting at step 16.		
19	With the test DVM LO input at tp407 of the Logic Assembly check for +34 ±1V dc at tp405 and +5 ±0.25V dc at tp409.		
20	Are both voltages within tolerance?	22	21
21	Check the 21V rms and 8.5V rms inputs from the Auxiliary Power Supply. Check the respective rectifiers CR18 and CR17 and their associated components. Repair as required then repeat the test starting at step 19.		
22	Set the POWER switch to OFF.		
23	Perform or verify the preparation portion of the calibration procedure contained in paragraphs 4-32 through 4-47. Insure the Preamplifier and Power Amplifier shields are replaced.		
24	Connect the HV Power Line cord to the autotransformer and set the autotransformer output voltage to the nominal line voltage.		
25	Verify the Power switch is OFF.		
26	Set the POWER switch to ON.		
27	Did the INSTRUMENT ON indicator illuminate, are all other indicators extinguished and is the fan audible? (A momentary flash of the FAULT indicator is normal.)	31	28
28	Is the trouble the absence of a valid response?	29	30
29	If the fan is not audible check the input auxiliary power, the POWER switch, the power jumper connections and the fan itself. If none of the indicators illuminate check the outputs of Transformer T3 in the Power Supply. If the incandescent lamp indicator INSTRUMENT ON does not illuminate check the bulbs and the +28V Power Supply on the Logic Assembly. For the LED indicators check the LEDs and the +5V Power Supply. Check the Warm-Up Delay circuit and CR24 if the WARMUP indicator does not illuminate. Repair as required then repeat the test beginning at step 23.		
30	Perform the applicable portions of the following step for the presence of an invalid response. If the FAULT indicator illuminates and stays illuminated check the logic inputs to the Fault Gate (U44 Logic Assy), including the signals that effect the gate by clearing the Trouble FF, or for the presence of an Operate Command from the Interface circuits. Use the Logic Trip Adjustment procedure in paragraph 4-129 to set the indication for the +5 volts if applicable.		

Table 4-4. Troubleshooting (Cont.)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
30 (cont)	If the FAULT indicator illuminates after a delay of approximately 6 seconds check the Fault Gate input from the switch controlled by the Fan air speed. If the OVERLOAD indicator illuminates check the disabling circuit between the Warm-Up Delay circuit and U8-11 on the Logic Assy. Repair as required then repeat the test beginning at step 23.		
31	After a delay of approximately 30 seconds does the WARMUP indicator extinguish and the FAULT and OVERLOAD indicator remain extinguished?	39	32
32	Does the WARMUP indicator remain illuminated?	33	34
33	Check the Warm-Up Delay circuitry. Repair as required then repeat the test beginning at step 23.		
34	Is the FAULT indicator illuminated and the OVERLOAD indicator extinguished?	35	36
35	Check the inputs to the Fault Gate, especially the ± Supply Current Monitor input to the comparator from the power supply assy. Repair as required then repeat the test beginning at step 23.		
36	Is the OVERLOAD indicator illuminated and the FAULT indicator extinguished?	37	38
37	Check the Overload Delay circuitry on the Logic Assy and its input from the Overload and Logic circuitry on the Preamplifier assembly. Repair as required then repeat the test beginning at step 23.		
38	When both FAULT and OVERLOAD indicators are illuminated check the Overload Delay circuitry on the Logic Assy and its input from the Overload and Logic circuitry on the Preamplifier assembly. Check the inputs to the comparators that control the Fault Gate and Trouble Flip Flop. Repair as required and then repeat the test beginning at step 23.		
39	Set the 5200A switch to OPERATE.		
40	Does the OPERATE indicator illuminate and the FAULT and OVERLOAD indicators remain extinguished? (Disregard momentary flashes of the FAULT and OVERLOAD indicators during switching.)	48	41
41	Does the OPERATE indicator fail to illuminate and the FAULT and OVERLOAD indicators remain extinguished?	42	43
42	Check the Operate Command through the Interface circuit and the Operate Flip Flop. Repair as required then repeat the test beginning at step 39.		
43	Does the OPERATE indicator illuminate momentarily then extinguish and the FAULT indicators illuminate?	45	44

Table 4-4. Troubleshooting (Cont.)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
44	For an OVERLOAD indication without a FAULT indication, check the input to the Overload Delay circuitry from the Preamplifier and the Input and Output stages of the Preamplifier, and the Output stage of the Power Amplifier for loading then repeat the test beginning at step 39.		
45	To isolate the problem determine whether the fault is major or minor, as defined in the Theory of Operation, paragraph 3-36 through 3-45. Set the 5200A MODE switch to STDBY. If the FAULT indicator extinguishes the fault is minor and the MODE switch may be set to OPERATE. If the FAULT indicator remains illuminated the fault is major and the POWER switch must be set to OFF to clear the fault. Then resume operations by setting the POWER switch to ON and after the Warmup period the 5200A MODE switch to OPERATE.		
46	Does the Fault remain after the circuitry has been reset at least once?	47	48
47	For a minor fault determine whether the input at U15-3, U15-4 or U15-5 is clearing the Operate FF, and from there back to the Fault Gate (U44), NEG HV or the Warm-Up Delay circuitry respectively. For an OVERLOAD indication in addition to the FAULT indication check the NEG HV and OVERLOAD inputs to the Fault and Overload Delay Circuitry from the Preamplifier Logic Circuitry. For a major fault determine whether the input at U15-9, U15-10 or U15-11 is clearing the Trouble FF, and from there back to the Operate Circuit, U21 comparator, U22 comparator or SENSE HV circuitry respectively. Repair as required then repeat the test beginning at step 39.		
48	Set the 5200A MODE switch to STDBY, the POWER switch to OFF and the Autotransformer output to zero volts. **WARNING!** **Lethal voltages are present during the following tests. Read Test preparation and prepare the equipment as described in paragraphs 4-44 through 4-52 before continuing.**		
49	Perform the Upper Tube Balance calibration starting at paragraph 4-53;		
50	Are the readings on the oscilloscope and DVM adjustable with stated tolerances?	52	51
51	Check the Upper Tube stage and its regulating circuit. Repair as required then repeat the test beginning at step 49.		
52	Perform the Lower Tube Balance calibration starting at paragraph 4-55.		
53	Are the readings on the oscilloscope and DVM adjustable within the stated tolerances?	55	54
54	Check the Lower Tube stage and its regulated circuit. Repair as required then repeat the test beginning at step 52.		
55	Perform the Output Stage Bias Current Calibration starting at paragraph 4-58.		
56	Are the readings on the oscilloscope and DVM adjustable within the stated tolerance?	58	57

Table 4-4. Troubleshooting (Cont.)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
57	Check the output stage class AB Amplifier (Q11 and Q12) and their associated components. Repair as required then repeat the test beginning at step 55.		
58	Perform the LED Loop Bias Current Calibration starting at paragraph 4-61.		
59	Is the oscilloscope current display adjustable to within the stated tolerance?	61	60
60	Check the Power Amplifier 30mA current source stage. Repair as required then repeat the test beginning at step 58.		
61	Perform the LED Loop Bandwidth Calibration starting at paragraph 4-64.		
62	Is the oscilloscope current display adjustable to within the stated tolerance?	64	63
63	Check the Power Amplifier 30 mA current source stage. Repair as required then repeat the test beginning at step 61.		
64	Perform the Screen Voltage Calibration starting at paragraph 4-67.		
65	Is the Lower Tubes Absolute Screen Voltage adjustable within the stated tolerance?	67	66
66	Check the Lower Tubes screen regulator circuitry. Repair as required then repeat the test beginning at step 63.		
67	Is the Upper Tube Absolute Screen Voltage adjustable within the stated tolerance?	69	68
68	Check the Upper Tubes Screen Regulator Circuitry. Repair as required then repeat the test beginning at step 64.		
69	Perform the Positive and Negative Current Trip Level Adjustment in paragraphs 4-70 thru 4-75.		
70	Are the Current Trip Circuits adjustable within the stated tolerance?	72	71
71	Check the Logic Assembly Fault and Comparator circuits and the input from the Power Supply. Repair as required then repeat the test starting at step 69.		
72	Perform the Preamplifier ± 15 Supply Voltage Calibration. Start with the preparation procedure in paragraph 4-77.		
73	Are the ± 15 Volt supplies adjustable within the stated tolerances?	75	74
74	Check the ± 15 Volt power supply and its 31V rms input from the Auxiliary supply. Repair as required then repeat the test starting at step 72.		
75	Perform the Preamplifier Minimum Negative High Voltage Trigger Level Calibration starting at paragraph 4-85.		

Table 4-4. Troubleshooting (Cont.)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
76	Is the result of the test acceptable?	78	77
77	Check the −2.5kV input to the Preamplifier, the Logic Stage of the Preamplifier and the Fault circuits on the Logic Assembly. Repair as required then repeat the test starting at step 75.		
78	Perform the Preamplifier Overload Trigger Balance Calibration starting at paragraph 4-88.		
79	Is the DC Balance adjustable within the stated tolerance?	81	80
80	Check the Power Amp 30 mA current source the Preamplifier output state and the Preamplifier Input stage (input amp in particular). Repair as required then repeat the test starting at step 78.		
81	Is the AC Balance adjustable within the stated tolerance?	83	82
82	Check the Preamplifier Input and Overload stages, in particular check the Slew Rate Sense Amplifier. Repair as required then repeat the test starting at step 78.		
83	Prepare the instrument for further calibration as outlined in the Calibration Point Adjustments (paragraph 4-91 procedures.		
84	Perform the DC Offset Calibration starting at paragraphs 4-95.		
85	Is the DC Offset adjustable within the stated tolerance?	87	86
86	Check the Preamplifier Input stage, the Input amplifier in particular. Repair as required then repeat the test starting at step 84.		
87	Perform the Low and High Frequency Gain Adjustment Procedure starting at paragraph 4-98.		
88	Is the transfer standard null obtainable to the stated tolerances?	90	89
89	Check the Preamplifier feedback circuits. If the 5215A has maximum output regardless of the 5200A setting check the sensing circuits (op amp, divider, cables and associated components). Repair as required then repeat the test starting at step 87.		
90	Troubleshooting of the 5215A Power Amplifier is complete. If any component was replaced or an adjustment changed a calibration procedure should be performed.		

Section 5

List of Replaceable Parts

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TABLE	ASSEMBLY NAME	PART NO.	PAGE
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5-3	PCB Assembly, Power Supply	362111	5-19
5-4	PCB Assembly, Logic	336826	5-21
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5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the Instrument. Components are listed alphanumerically by assembly. Electrical components are listed by item number. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

a. Reference Designation or Item Number.

b. Description of each part.

c. Fluke Stock Number.

d. Federal Supply Code for Manufacturers. (See Section 7 for Code-to-Name list.)

e. Manufacturer's Part Number or Type.

f. Total Quantity per assembly of component.

g. Recommended Quantity: This entry indicates the recommending number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc., that are not always part of the instrument, or are deviations from the basic instrument model, the REQ QTY column lists the recommended quantity of the item in that particular assembly.

h. Use Code is provided to identify certain parts that have been added, deleted or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity, paragraph 5-7.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information:

a. Quantity.

b. Fluke Stock Number.

c. Description.

d. Reference Designation or Item Number.

e. Printed Circuit Board Part Number.

f. Instrument Model and Serial Number.

5-7. USE CODE EFFECTIVITY LIST

USE CODE	SERIAL NUMBER EFFECTIVITY

Table 5-1. Final Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	FINAL ASSEMBLY (Figure 5-1 thru 5-9)						
	Power Switches View (Figure 5-1)						
101	Angle, Power Switch	336701	89536	336701	1		
102	Bracket, Angle	356030	89536	356030	1		
103	Bracket, Center	400887	89536	400887	1		
104	Bracket, Power Switch	336693	89536	336693	1		
105	Coupler, Disc.	360537	89536	360537	1		
106	Switch, Toggle	326363	27191	8822K20	2		
	Rear Panel View (Figure 5-2)						
201	Bushing, Strain Relief, Aux line	436394	28520	SR6P3-4	1		
202	Bushing, Strain Relief, HV Line	102194	28520	SR-8P-2	1		
203	Connector, Female, 3 prong	247015	73586	M-1538GS	1		
204	Cord Set, Auxiliary	409920	89536	409920	1		
205	Cord Set, High Voltage	409912	89536	409912	1		
206	Fuse Holder	407775	75915	341-001AL	2		
207	Fuse, Slo-Blow, 5A (Aux Supply)	109215	71400	MDA-TYPE	1		
208	Fuse, Slo-Blow, 15A (HV Supply)	392936	71400	MDA-TYPE	1		
209	Handle, Corner	295691	89536	295691	4		
210	Hole Plug, Snap Button, 3/8"	441311	HEYCO	P-375	1		
211	Hole Plug, Snap Button, 5/8"	407502	HEYCO	P-625	1		
212	Panel, Rear	336446	89536	336446	1		
213	Plate, Rear	336495	89536	336495	1		
214	Plate, Spacer	336966	89536	336966	1		
215	Strap, Rubber, Mousetail	104794	98159	2829-115-3	1		

NOTE: ITEMS ILLUSTRATED BUT NOT CALLED OUT ARE COMMON HARDWARE.

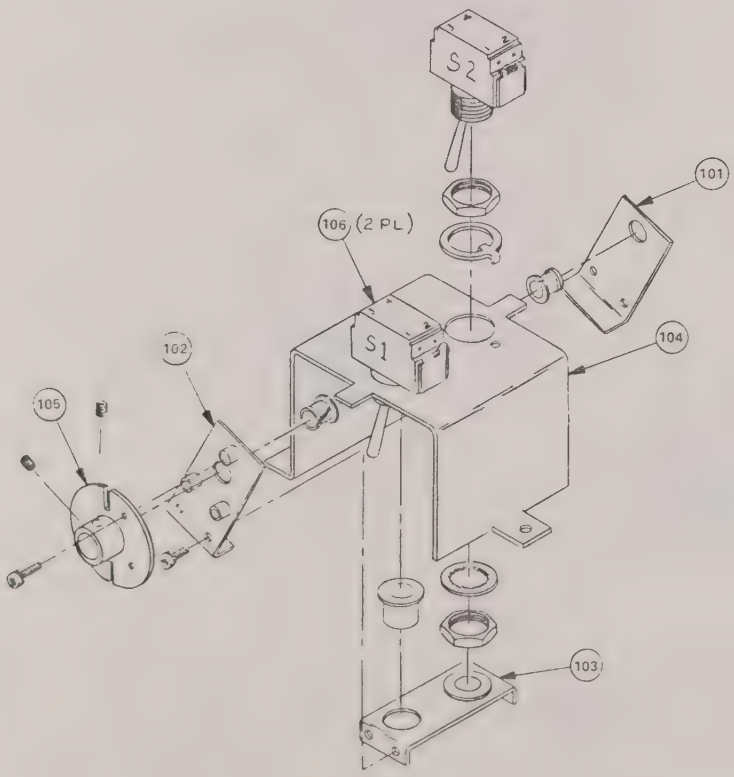


Figure 5-1. Power Switches View

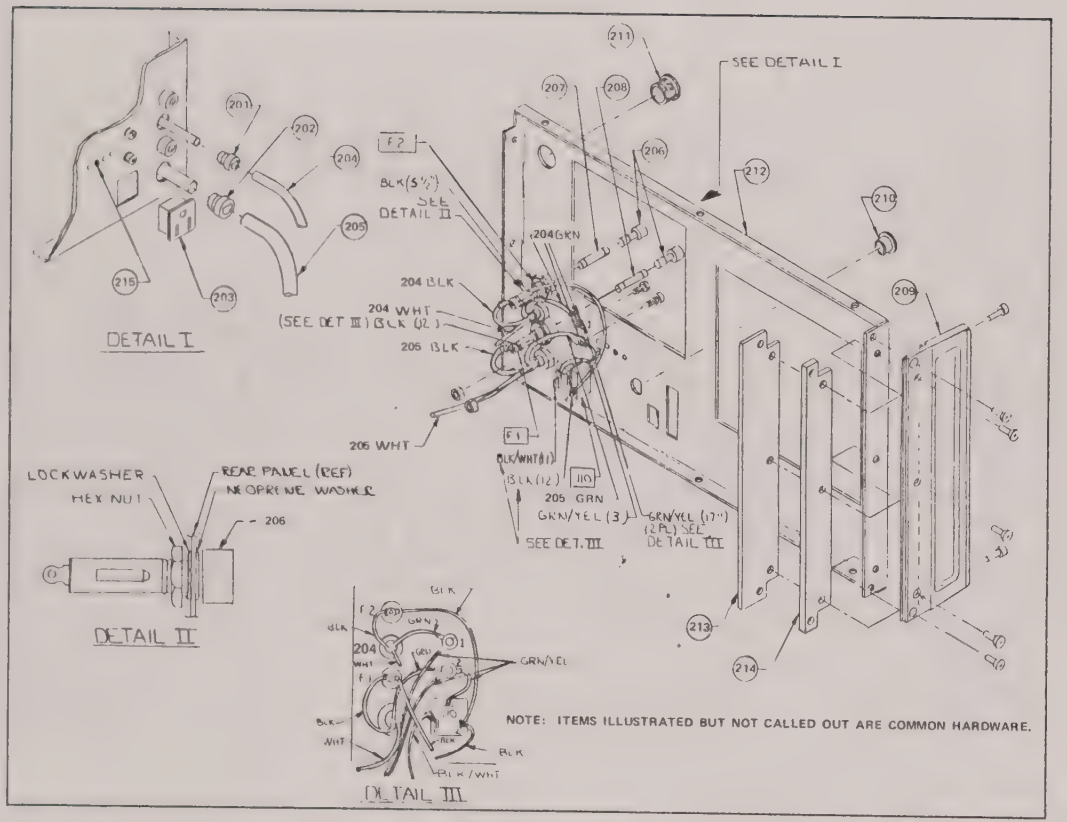
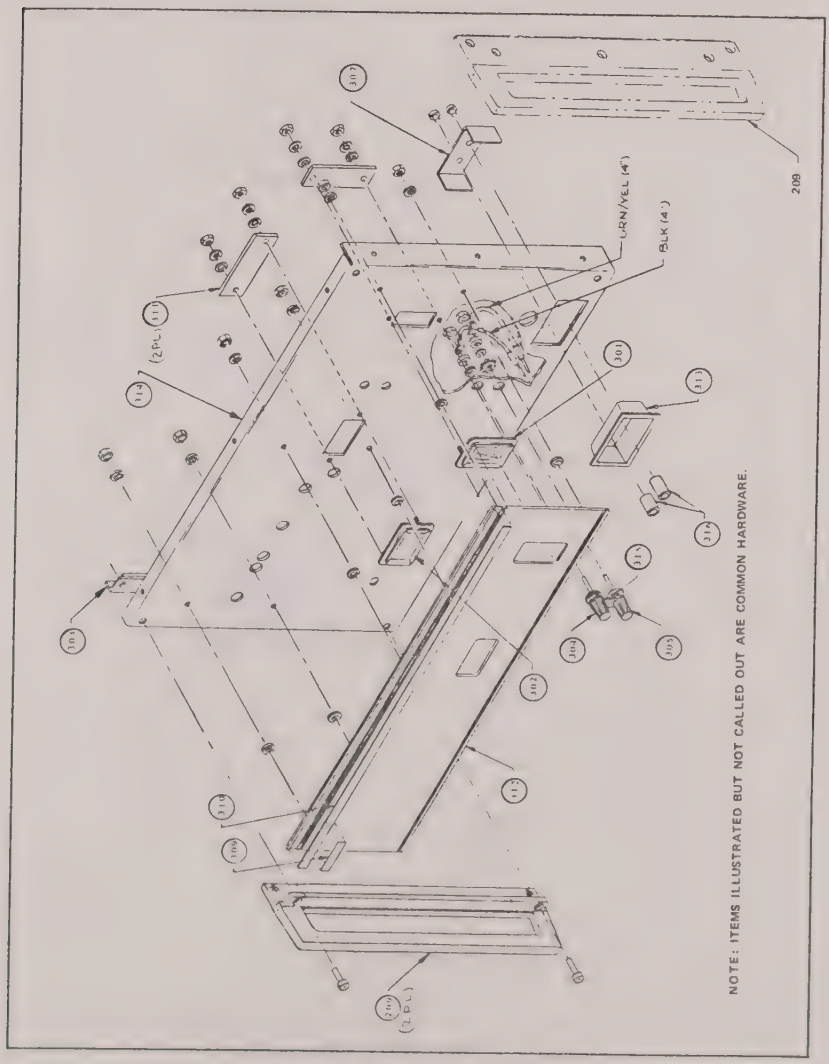


Figure 5-2. Rear Panel View

Table 5-1. Final Assembly (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Front Panel View (Figure 5-3)						
301	Betel, Window, HV Symbol	341768	89536	341768	1		
302	Betel, Window, Operate	367656	89536	367656	1		
303	Bracket, Corner Angle	298141	89536	298141	2		
304	Binding Post, Black	275560	32767	820-45	1		
305	Binding Post, White	275586	32767	820-25	1		
307	Clamp, Cable Storage	346742	89536	346742	1		
309	Decal, Fluke Logo and Serial Number	194183	89536	194183	1		
310	Decal Title	428995	89536	428995	1		
311	Diffuser	351338	89536	351338	2		
312	Extrusion, Front Panel, Screened	439216	89536	439216	1		
313	Housing, Cable Plug	346536	89536	346536	1		
314	Panel Front	439208	89536	439208	1		
315	Shorting Link	190728	83330	21171			
316	Spacer, Cable Storage	346726	89536	346726	2		
	Tube Chamber View (Figure 5-4)						
401	Card Guide	229047	23880	1800F	8		
402	Switch, Air	417602	89536	417402	1		
403	Assy, Tube Chamber	337402	89536	337402	1		
	Left Side View (Figure 5-5)						
501	Bracket, Angle	166322	73734	1552	2		
502	Assy, Cable	349589	89536	349589	1		
503	Relay Armature	387415	78290	425BXXW	1		
504	Sidewall, Left	336529	89536	336529	1		
505	Switch, Pushbutton	408500	01963	E69-30A	1		
506	Tap Board	336743	89536	336743	1		


NOTE: ITEMS ILLUSTRATED BUT NOT CALLED OUT ARE COMMON HARDWARE.
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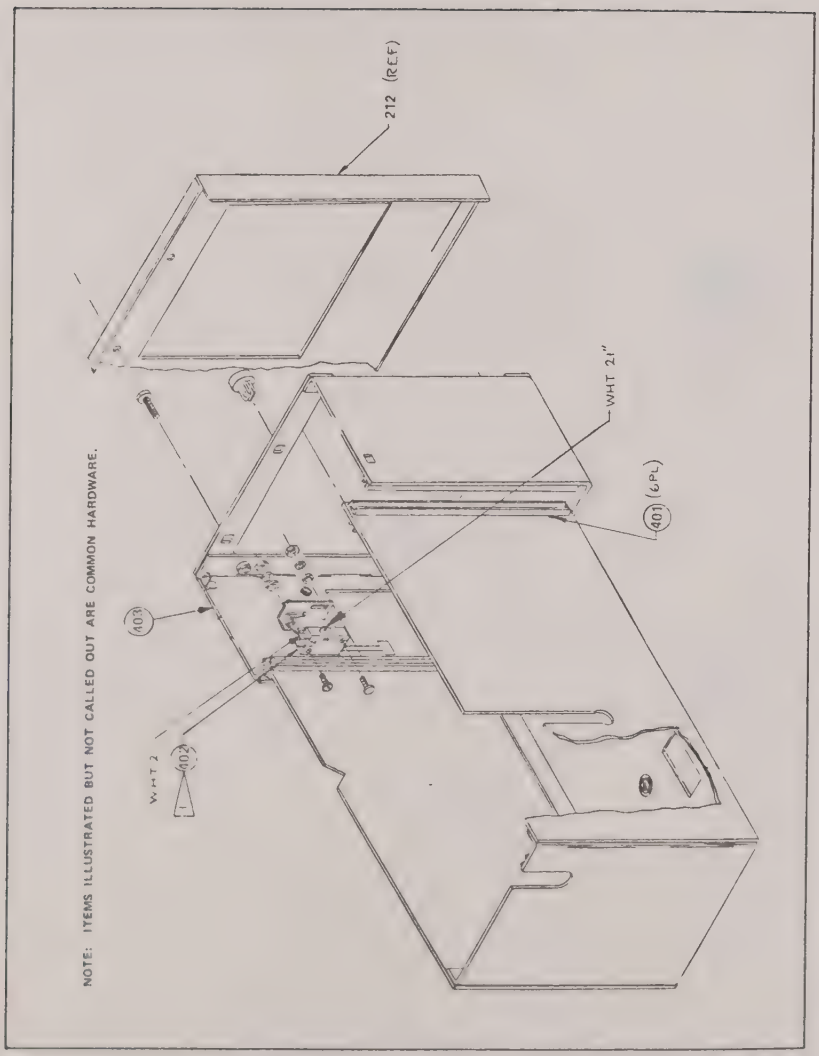


Figure 5-4. Tube Chamber View

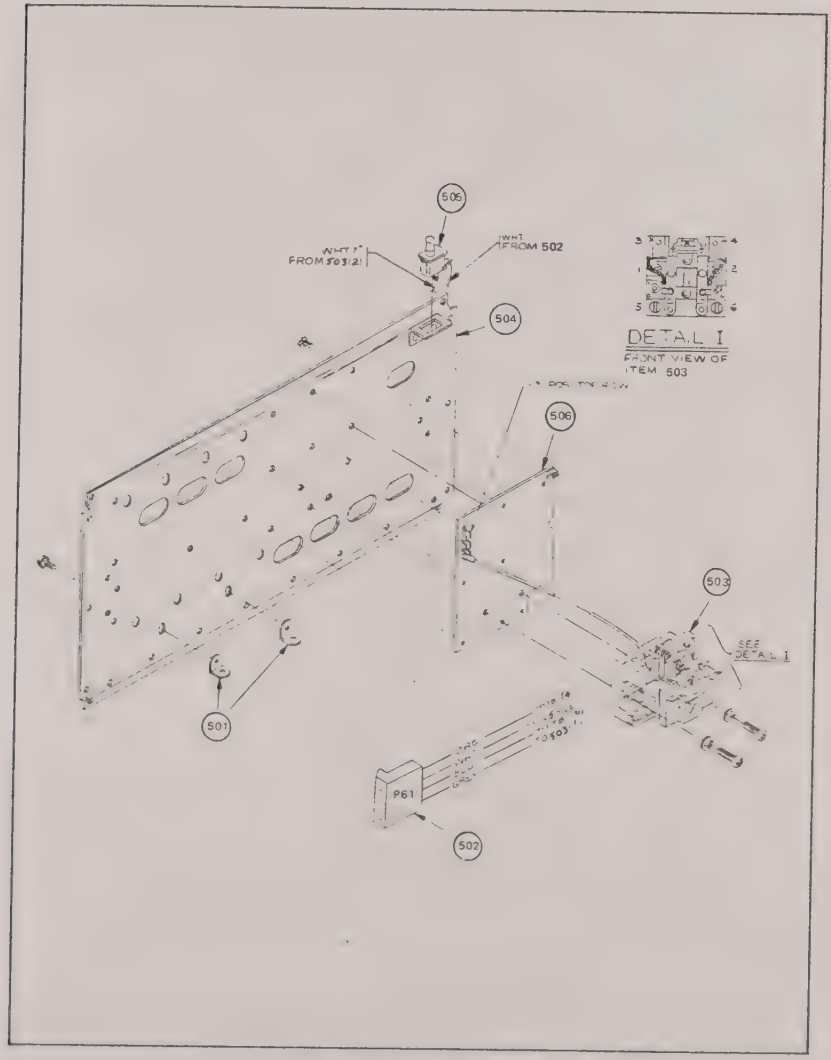


Figure 5-5. Left Side View

Table 5-1. Final Assembly (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Power Supply View (Figure 5-6)						
C11, C12	Cap, Oil filled 4 uF ±15%, 400V	387431	00646	CKM2-40-4M53	2		
C13	Cap, Oil filled, 1 uF ±10%, 400V	387423	00686	CKM2-40-1M	1		
T3	Transformer, Preamp	336917	89536	336917	1		
T4	Transformer, Power Amp	397844	89536	397844	1		
601	Assy, PCB, Mother	336818	89536	336818	1		
602	Assy, Bleeder Power Amp	401000	89536	401000	2		
R1 thru R5	Res, comp, 1M ±10%, 2W	136671	01121	HB3341	5		
603	Assy, Bleeder, Preamp	400994	89536	400994	1		
R1 thru R5	Res, comp, 330k ±10%, 2W	208227	01121	HB1051	5		
604	Bracket, fan	336552	89536	336552	1		
605	Bracket, Transformer	336453	89536	336453	1		
606	Cable Assy, Preamp HV	349517	89536	349517	1		
607	Cable Assy, Neg HV	346601	89536	346601	1		
608	Cable Assy, Pos HB	346569	89536	346569	1		
609	Clamp, HV	419473	89536	419473	1		
610	Instrument Bottom	336479	89536	336479	1		
611	Shaft, Power Switch	400960	89536	300960	1		
	Low Capacity View (Figure 5-7)						
T2	Transformer, Lo Cap	336909	89536	336909	1		
701	Bulkhead, Central	336461	89536	336461	1		
702	Clamp, Lo Cap Xfmr	400895	89536	400895	1		
703	Screen	401034	89536	401034	1		

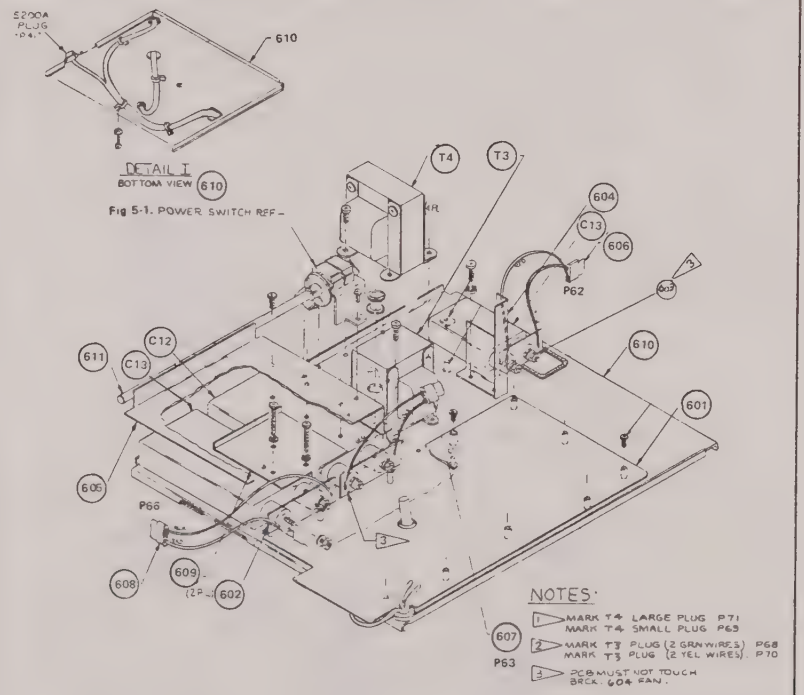
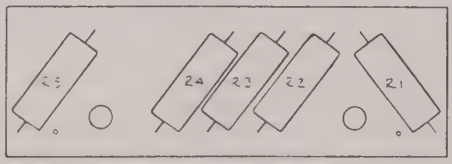
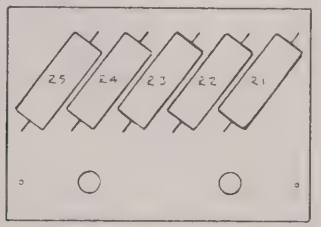


Fig 5-1. POWER SWITCH REF—

NOTE: ITEMS ILLUSTRATED BUT NOT CALLED OUT ARE COMMON HARDWARE.



POWER AMP BLEEDER PCB ASSY



PREAMP BLEEDER PCB ASSY

Figure 5-6. Power Supply View

NOTE: ITEMS ILLUSTRATED BUT NOT CALLED OUT ARE COMMON HARDWARE.

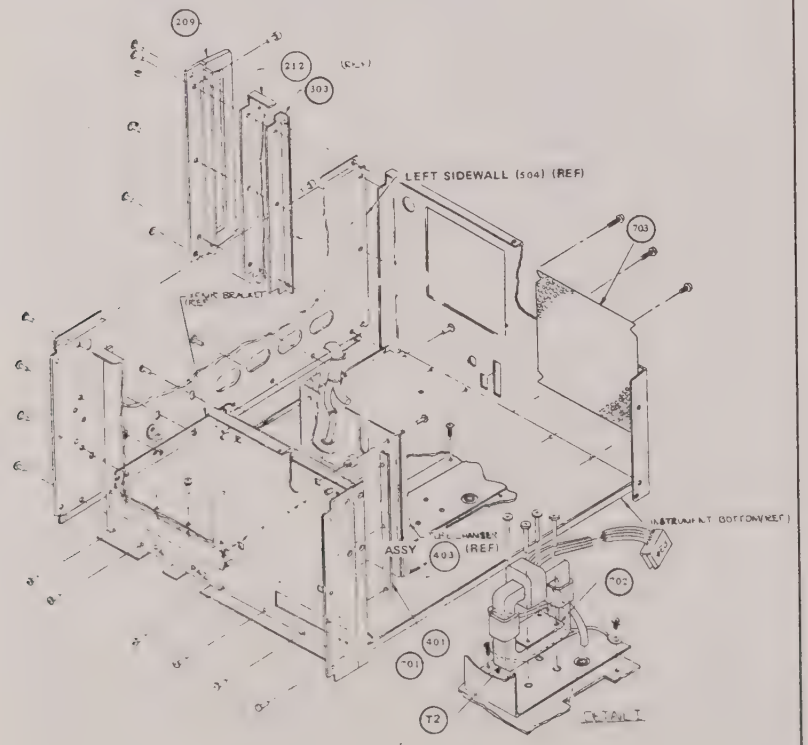
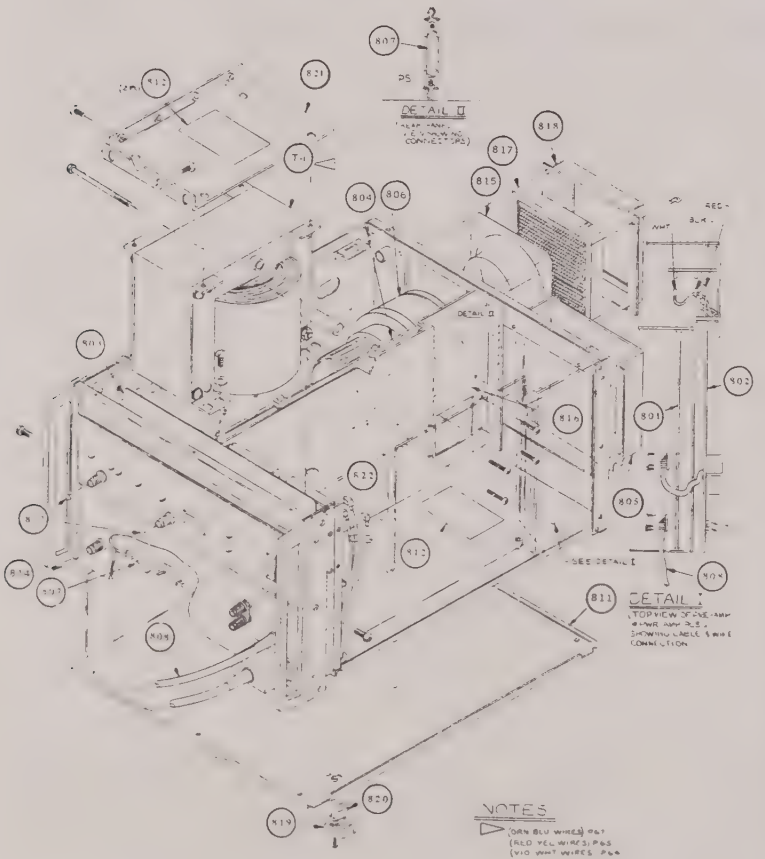


Figure 5-7. Low Capacity View

Table 5-1. Final Assembly (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Interior View (Figure 5-8)						
T1	Transformer, HV	336891	89536	336891	1		
801	Assy, Power Amp.	341511	89536	341511	1		
802	Assy, Preamp	439299	89536	439299	1		
803	Assy, Logic PCB	439307	89536	439307	1		
804	Assy, Power Supply PCB	362111	89536	362111	1		
805	Airduct	400861	89536	400861	1		
806	Blower	330068	82877	VS37A2-12	1		
807	Cable Assy, Control, (P5 to P41, J25 & J26)	346544	89536	346544	1		
808	Cable Assy, Output	341552	89536	341552	1		
810	Clamp, Cable, Nylon (Not illustrated rear of Front Panel)	102265	06383	SST-2	1		
811	Cover, Bottom	336677	89536	336677	1		
812	Decal, Danger	336859	89536	336859	2		
814	Decal, Knob, Green	341339	89536	341339	1		
815	Fan Intake, Bellmouthed	336503	89536	336503	1		
816	Fan Nut Plate	336545	89536	336545	1		
817	Filter Intake	402834	89536	402834	1		
818	Frame, Filter	400945	89536	400945	1		
819	Foot, Bail Stand	292870	89536	292870	6		
820	Foot Insert, Nonskid	420422	89536	420422	6		
821	Plate, Power Transformer	400309	89536	400309	1		
822	Plate, Spacer	336966	89536	336966	1		
823	Spring Clip	330134	02660	17-529	1		
824	Spacer	403071	89536	403071	1		
825	Plate, Connector Cover	439604	89536	439604	1		



NOTE: ITEMS ILLUSTRATED BUT NOT CALLED OUT ARE COMMON HARDWARE

Figure 5-8. Interior View

Table 5-1. Final Assembly (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Exterior View (Figure 5-9)						
901	Cover, Low Capacity Chamber	336636	89536	336636	1		
902	Cover, Right Side	337410	89536	337410	1		
903	Cover, Top	336669	89536	336669	1		
904	Cover, Transformer	336644	89536	336644	1		
905	Cover, Tube Chamber	336594	89536	336594	1		
906	Decal, Corner	296293	89536	296293	4		
907	Decal, Handle Trim	295527	89536	295527	4		
908	Decal, Side Trim	295402	89536	295402	2		
909	Decal, Danger	336719	89536	336719	2		
910	Decal, HV	349464	89536	349464	1		
911	Decal, Ground	349456	89536	349456	1		
912	Shield, Pre Amp	353425	89536	353425	1		
913	Sidewall, Right	336537	89536	336537	1		
914	Plug, Hole	441253	89536	441253	5		
915	Kit Accessory (Not illustrated)	440149	89536	440149	1		
	Cable Assy, Interconnect (5205A to 5200A)	341560	89536	341560	1		
	PCB, Shorting	400762	89536	400762	3		

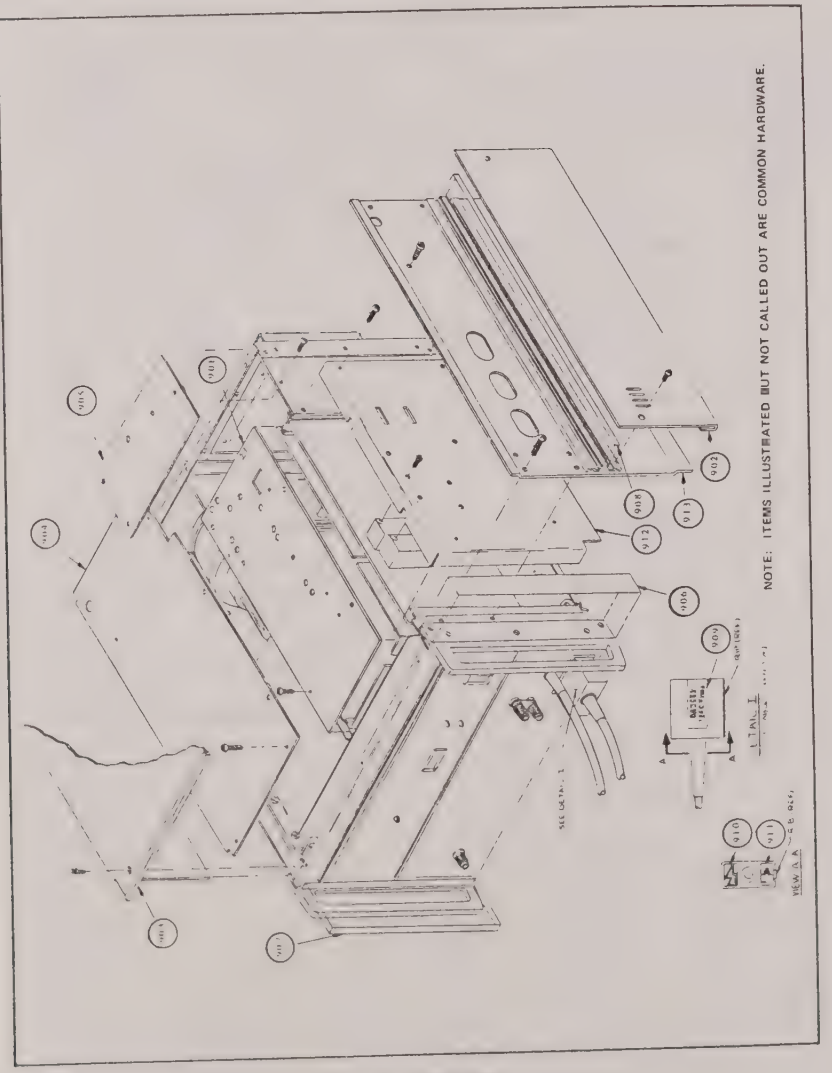


Figure 5-9. Exterior View

Table 5-2. PCB Assembly, Motherboard

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	PCB ASSY. MOTHERBOARD (Figure 5-10)	336818	89536	336818	REF		
E1	Protector, Spark Gap	198507	25088	B1F90	1		
J20, J21	Connector, 9 position/2 removed	352682	00779	583694-2	2		
J22	Connector, 3 position	291625	00779	583650-1	1		
J23	Connector, 6 position	291898	00779	583650-2	1		
J30	Connector 5 position/1 removed	404020	00779	583694-7	1		
J31	Connector 20 position/6 removed	403980	00779	583694-3	1		
J43	Connector 15 position	291948	00779	583650-7	1		
J44, J45	Connector 5 position	403964	00779	583407-6	2		
J50	Connector 11 position/2 removed	404012	00779	583694-6	1		
J51	Connector 9 position/4 removed	403998	00779	583694-4	1		
J52	Connector 11 position/2 removed	404004	00779	583694-5	1		
J53	Connector 7 position	403972	00779	583407-8	1		
J54, J56	Connector 4 position/	354951	00779	583407-5	2		
OL	Connector, Black	149112	74970	105-0753	1		
Chas GND	Connector, Green	149120	74970	105-0754	1		
VR1, VR2	Diode Zener	113365	31483	69-4978	2		

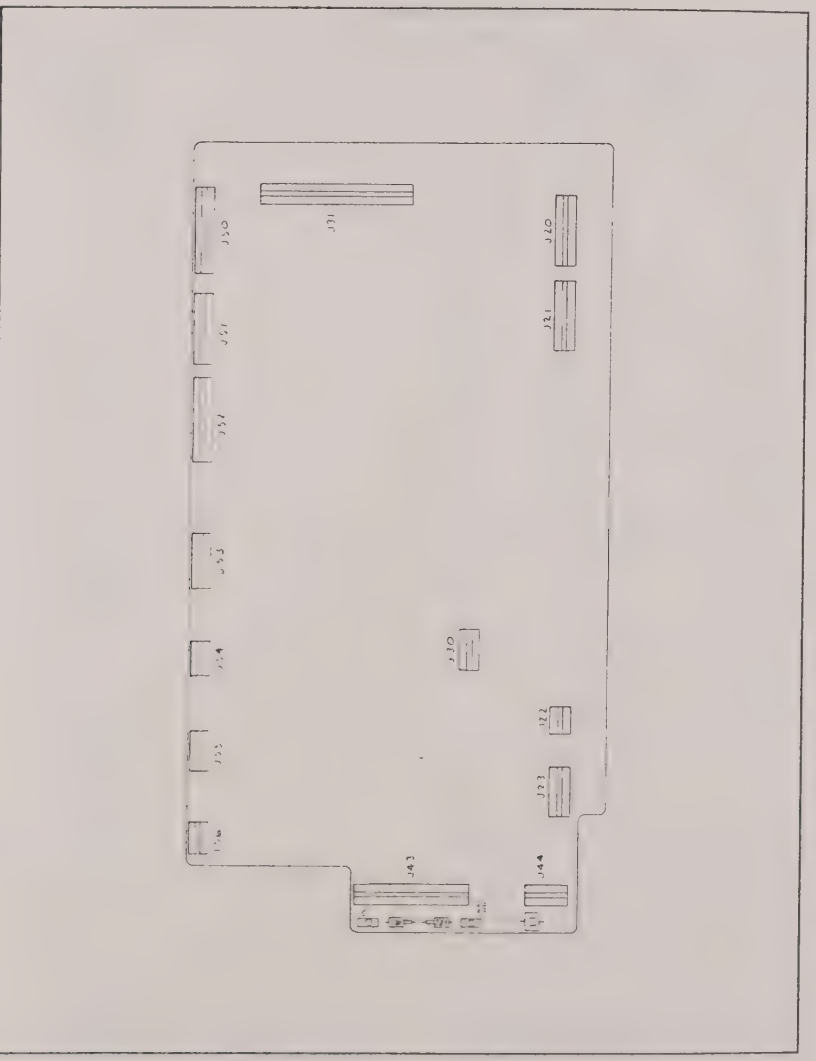


Figure 5-10. PCB Assy, Motherboard

Table 5-3. PCB Assy, Power Supply

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	PCB ASSY, POWER SUPPLY (Figure 8-2)	362111	89536	362111	REF		
C1	Capacitor, elect, 10 μf ± , 300V	340885	56289	500D106F-300DC7	1		
CR1 thru CR4, CR7, CR17, CR18, CR25, CR26	Diode	368738	04713	1N4004	9		
CR6, CR8	Diode	203323	07919	1N448	2		
CR11 thru CR16, CR21 thru CR24	Diode	268433	04713	MR250-5	10		
J61, J64	Connector, 4 pin	385443	27264	09-65=1041	2		
J62, J63, J65, J66, J67, J69	Connector, 2 pin	413914	27264	09-65-1041	6		
J68, J70, J71	Connector, 15 pin	310094	27254	03-09-2151	3		
Q1, Q3	Transistor	218511	95303	65120	2		
Q2	Transistor	284448	89536	284448	1		
R1, R20	Res, comp, 220 ±5%, ¼W	147959	01121	CB2215	2		
R2	Res, comp, 220k ±5%, ½W	108217	01121	CB2245	1		

Table 5-3. PCB Assy, Power Supply (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R3	Res, com, 8.2k ±5%, ¼W	160796	01121	CB8225	1		
R4	Res, comp, 3.3k ±5%, ¼W	148056	01121	CB3325	1		
R5	Res, comp, 470k ±5%, ½W	108969	01121	EB4745	1		
U1	Opto-Isolator	380014	29013	MCT-2	1		
VR5	Diode, zener, 110V	392878	07910	1N986B	1		
	Connector Pin	342998	27269	02-09-1118	31		
	Guide, retainer	341115	89536	341115	3		
	Heat Sink (Q3)	104562	05820	NF-209	1		
	Transipad (Q1, Q2, Q3)	152207	07047	10123DAP	3		

Table 5-4. PCB Assembly, Logic

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	PCB ASSY, LOGIC (Figure 8-4)	346338	89536	346338	REF		
	Assy, LED Standoff	341594	89536	341594	7		
	Assy, High Voltage Lamps	400986	89536	100986	1		
	Bracket, HV Lamps	400747	89536	400747	1		
	Plug, Banana	352716	83330	431	2		
	Socket, Bayonet Base	103523	95213	7-08	2		
	Assy, Operate Lamps	400978	89536	400978	1		
	Mounting, Operate Lamps	400739	89536	400739	1		
	Plug, Banana	352716	83330	431	3		
	Socket, Lamp	184002	95263	7-12	2		
C1,C3, C10, C12, C46, C49, C55, C56, C99	Cap, fxd, cer, 0.05 µf ±20%, 100V	149161	56289	55C23A1	9		
C2	Cap, fxd, Ta, 15 µf ±20%, 6V	161935	56289	196D156X-0006	1		
C4,C15, C21, C90, C94	Cap, fxd, Ta, 6.8 µf ±10%, 35V	182782	56289	150D685X903-582	5		
C5,C30 thru C33	Cap, fxd, cer, 0.1 µf ±20%, 100V	149146	56289	33C416B	5		
C14, C22, C23, C44	Cap, fxd, Ta, 1 µf ±20%, 35V	161919	56289	196D001X-03582	4		
C20	Cap, elect, 47 µf −10/+50%, 25V	168823	25403	ET470X0025 A4	1	1	
C25, C26, C27	Cap, elect, 1000 µf −10/±50%, 16V	193896	25403	ET102X016 A02	3	1	

Table 5-4. PCB Assembly, Logic (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C28	Cap, elect, 470 μF–10/+50%, 40V	185868	25403	ET471X040-A02	1	1	
C40	Cap, fxd, Ta 2.2 μF±20%, 15V	364216	56289	196D225X015-HA1	1		
C41	Cap, fxd, Ta, 0.33 μF±20%, 35V	408690	56289	196D334X035-HA	1		
C42, C45	Cap, fxd, Ta, 0.47 μF ±20%, 35V	161349	56289	196D474X035-HA1	2		
C43	Cap, fxd, Ta, 4.7 μF ±20%, 25V	161943	56289	196D475X025-KA1	1		
C47, C50	Cap, fxd, TA, 10 μF ±20%, 10V	176214	56289	196D106X010-KA1	2		
C48, C52	Cap, fxd, cer, 0.01 μF –20/+80%, 100V	105668	00656	C023B501J103M	2		
C53	Cap, fxd, plastc, 5 μF ±5%, 150V	364190	20908	Type X564	1		
C54	Cap, Ta, elect, 220 μF ±10%, 10V	182840	56289	150D227X901-0S2	1	1	
C98, C102	Cap, Ta, elect, 68 μF ±10%, 15V	182824	56289	150D686X901-5R2	2	1	
CR10 thru CR13, CR16, CR30, CR40, CR42, CR43, CR74, CR97, CR101	Diode, Si, Hi-Speed switchng	203323	07910	1N448	12	3	
CR17, CR18	Rectifier, bridge	296509	09423	FB200	2	1	
CR24, CR26 CR27	Diode, light emitting	309617	07263	FLV102	3	1	
CR41	Diode, Si	348177	07263	FD7223	1	1	

Table 5-4. PCB Assembly, Logic (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
D1 thru DS4	Lamp, Incandescent	186346	71744	CM1819	4		
K1	Relay, dry reed	357566	71707	UF40069	1		
L1,L2	Choke, H turn	379222	89536	379222	2		
Q1,Q2	Xstr, Si, NPN, power	343970	04713	MPS-U06	2	1	
Q3,Q10	Xstr, Si, NPN	218396	04713	2N3904	2	1	
Q4	Sxtr, Si, PNP	288761	01295	SK6808	1	1	
Q5	Xstr, Si, NPN	203489	03508	11C-2322	1	1	
R1,R2, R4,R13	Res, fxd, comp, 2k ±5%, ¼W	202879	01121	CB2025	4		
R3,R21, R25, R27, R28, R38, R39, R40, R65, R83	Res, fxd, comp, 4.7k ±5%, ¼W	148072	01121	CB4725	10		
R5, R120, R122 thru R125	Res, fxd, comp, 33 +5%, ¼W	175034	01121	CB3305	6		
R6, R26, R35, R36, R100, R101, R105, R106, R127	Res, fxd, comp, 220 ±5%, ¼W	147959	01121	CB2215	9		

Table 5-4. PCB Assembly, Logic (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R73, R85, R86, R102, R103, R104, R114, R115, R128, R131	Res, fxd, comp, 10k ±5%, ¼W	148106	01121	CB1035	10		
R45, R46	Res, fxd, comp, 270 ±5%, ½W	159616	01121	EB2715	2		
R47	Res, var, cermet, 20k ±10%, ½W	355529	11236	362S203AZ	1		
R48, R49	Res, var, cermet, 100k ±10%, ½W	355537	11236	362S104AZ	2		
R50	Res, fxd met film, 30.1k ±1%, 1/8W	168286	91637	MFF1-83012F	1		
R51	Res. fxd. met film, 365k ±1%, 1/8W	289520	91637	MFF1-83653F	1		
R52	Res, fxd. met film, 383k ±1%, 1/8W	288498	91637	MFF1-83833F	1		
R53, R55, R74, R98	Res, fxd, comp, 100 ±5%, ¼W	147926	01121	CB1015	4		
R54	Res, fxd, comp, 3.3k ±5%, ½W	165761	01121	CB3325	1		
R60	Res, fxd, comp, 2.2k ±5%, ¼W	148049	01121	CB2225	1		
R61	Res, fxd, comp, 5.6k ±5%, ¼W	148080	01121	CB5625	1		
R62, R63, R95	Res, fxd, comp, 22k ±5%, ¼W	148130	01121	CB2235	3		
R66	Res, fxd, met film, 187k ±1%, 1/8W	289462	91637	MFF1-81873F	1		
R67	Res, fxd, met film, 48.7k ±1%, 1/8W	267385	91637	MFF1-81502F	7		
R70, R71, R76, R88, R89, R90, R94	Res, fxd, met flm, 15k ±1%, 1/8W	285296	91637	MFF1-81502F	7		

Table 5-4. PCB Assembly, Logic (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R72, R80, R202	Res, fxd, comp, 1k ±5%, ¼W	148023	01121	CB1025	3		
R77	Res, fxd, mat film, 909 ±1%, 1/8W	312629	91637	MFF1-89090F	1		
R81,R82, R121	Res, fxd, comp, 390 ±5%, ¼W	147975	01121	CB3915	3		
R87	Res, fxd, comp, 10 ±5%, ¼W	147868	01121	CB1005	1		
R91	Res, fxd, met film, 22.1k ±1%, 1/8W	235234	91637	MFF1-82212F	1		
R92	Res, fxd, met film, 421k ±1%, 1/8W	276626	91637	MFF1-84223F	1		
R93	Res, fxd, met film, 316k ±1%, 1/8	289496	91637	MFF1-83163F	1		
R96	Res, fxd, comp, 33k ±5%, 1/8W	148155	01121	CB3335	1		
R97	Res, fxd, comp, 100k ±5%, ¼W	148189	01121	CB1045	1		
R126, R130	Res, fxd, comp, 56k ±5%, ¼W	170738	01121	CB5635	2		
R129	Res, fxd, comp, 6.8M ±5%, ¼W	394064	01121	CB6865	1		
R201	Res, fxd, comp, 30k ±5%, ¼W	193417	01121	CB3035	1		
U1	IC, TTL, Dig. Dual NAND	352690	01295	SN7413N	1	1	
U2	IC, TTL, Hex, Inverter	379305	01295	SN7405N	1	1	
U3	IC, TTL, Dig. Quad 2-input positive NAND Gates	292961	01295	SN7403N	1	1	
U4	IC, TTL, Hex Inverter	292979	01295	SN7404N	1	1	
U5,U20	IC, TTL, Hex Inverter, Buffer &Driver	288605	01295	SN7416N	2	1	
U8	IC, TTL, Quad, 2-Input, Positive NAND	310201	01295	SN7438N	1	1	
U14	IC, TTL, Quad, 2-Input Pos OR Gate	342709	01295	SN7432N	1	1	
U15	IC, TTL, Triple-3-Input Positive NAND	363465	01295	SN7412N	1	1	
U21, U22	IC, Linear, Quad comparator	387233	12040	LM339N	2	1	
U25	IC, Linear, Voltage Regulator	327981	12040	LM309K	1	1	

Table 5-4. PCB Assembly, Logic (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U30, U31	Opto Isolator	387076	50579	ILD-74	2	1	
U40	IC, TTL, SSI, Hex/Quad	354886	01295	SN7414N	1	1	
U41	IC, TLT, Dual J-K Triggered, Flip-Flops	293100	01295	SN74H106N	1	1	
U42	IC, Linear, Dual Timer	387407	18324	NESS6A	1	1	
U43	IC, TTL, Quad, 2-Input	292953	01295	SN7400N	1	1	
U44	IC, TTL Positive NAND Gates, 8-Input	293019	01295	SN7430N	1	1	
VR3, VR6	Diode, zener	180455	07910	1N749A	2	1	
VR14	Diode, zener	172148	12065	1N3496	1	1	
XU14, XU15, UX22, XU42	Socket, IC	291542	00779	583527-1	5		
	Bracket, lamp	400754	89536	400754	2		
	Heatsink	342675	13103	600382	1		
	Jack, banana, nylon	162065	74970	108-902	5		
	Transipad, Xstr	152207	07047	10123DAP	1		

Table 5-5. Preamplifier Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Assembly, Preamplifier (Figure 5-11)	439281	89536	439281	1		
1	PCB Assy; Pre Amp (Refer to Table 5-6)	439240	89536	439240	1		
2	PCB Assy; Pre Amp Tube Anode (Refer to Table 5-7)	397281	89536	397281	1		
3	Cable Assy, Sense	349555	89536	349555	1		
4	Fence, Pre Amp	337444	89536	337444	1		
5	Fence, Pre Amp	439570	89536	439570	1		

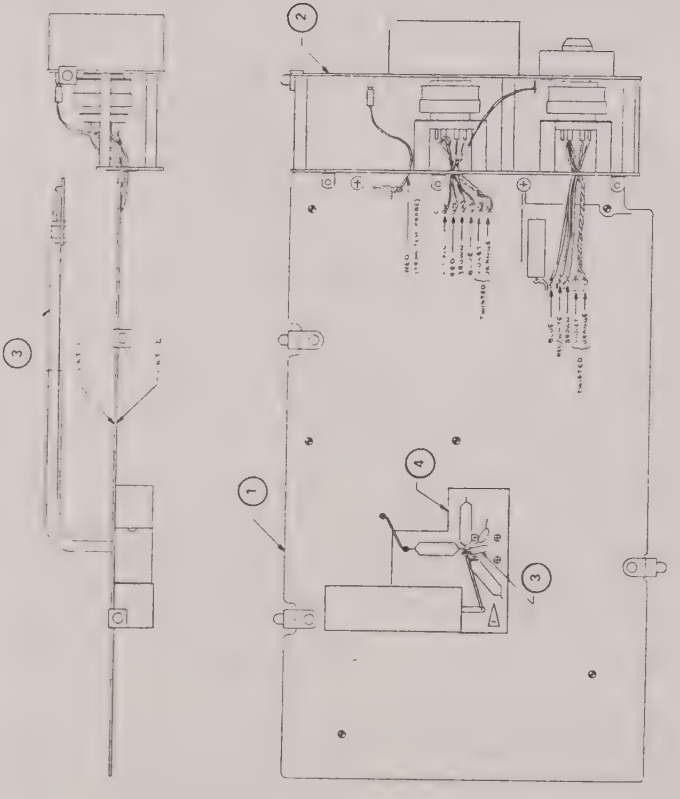


Figure 5-11. Preamplifier Assembly Locations

Table 5-6. Pre Amp PCB Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	PCB ASSEMBLY, PRE AMP (Figure 8-6a)	353656	89536	353656	REF		
	PCB Assembly, Zener String (See end of table)	362129	89536	362129	1		
C1	Cap, fxd, Ta, 22 uF ±20%, 35V	394775	56289	196D226X0035 T	1		
C6,C8, C9,C26, C121, C133, C176	Cap, fxd, cer, 0.01 uF ±20%, 100V	149153	56289	C023B101F103 M	7		
C7, C200	Cap, fxd, mica, 22 pF ±5%, 500V	148551	71236	DM15C220J	2		
C10, C124	Cap, fxd, mica, 150 pF ±5%, 500V	148478	71236	DM15F151J	2		
C11, C12, C84 thru C87	Cap, fxd, Ta, 22 uF ±20%, 20V	357780	56289	196D226X0020 P	6		
C13	Cap, fxd, mica, 8 pF ±10%, 500V	216986	71236	DM15C080K	1		
C14	Cap var, poly propyl, 2 - 22 pF	369207	80031	C010KA/20E	1		
C15, C79, C123	Cap, fxd, mica, 100 pF ±5%, 500V	148494	71236	DM15F101J	3		
C27	Cap, fxd, plstc, 0.01 uF ±10%, 50V	309906	06001	75F1R4A001	1		
C41	Cap, fxd, plstc, 0.0039 uF ±10%, 50V	386847	06001	75F1R5A392	1		
C46	Cap, fxd, Ta, 6.8 uF ±20%, 35V	363713	56289	196D685X0035 K	1		
C64, C65, C150	Cap, fxd, cer, 0.05 uF ±20%, 100V	149161	56289	5SC23A1	3		
C67	Cap, fxd, mica, 56 pF ±5%, 500V	148528	71236	DM15E560J	1		
C70, C71	Cap, fxd, elect, 470 uF -10/+50% 40V	185868	73445	ET471X040A02	2	1	

Table 5-6. Pre Amp PCB Assembly (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C72, C83	Cap, fxd, cer, 2000 pF ± gmv, 11KV	105569	71590	DA140-139CB	2		
C73	Cap, fxd, mica, 30 pF ±5%, 500V	340570	71236	DM15E300J	1		
C75	Cap, fxd, Ta, 1uF ±20%, 35V	161919	56289	196D105X0035	1		
C91	Cap, fxd, cer, 1pF ±20%, 4000V	393892	32897	858-000-C0K10 9M	1		
C92	Cap, fxd, plstc, 0.22 uF ±10%, 50V	271874	06001	75F4R5A224	1		
C94	Cap, fxd, Ta, 15 uF ±20%, 6V	161935	56289	196D156X0006	1		
C105, C106	Cap, fxd, mica, 360 pF ±1%, 500V	170407	71236	DM15F361F	2		
C128, C161	Cap, fxd, cer, 0.1 uF ±20%, 100V	149146	56289	33C41B6	2		
C132	Cap, fxd, mica, 5.6 pF ±5%, 500V	329631	71236	DM15C560J	1		
C135	Cap, fxd, Ta, 4.7 uF ±20%, 25V	161943	56289	196D475X0025 J	1		
C145, C146	Cap, fxd, mica, 33 pF ±5%, 500V	160317	71236	DM15E330J	2		
C148	Cap, fxd, mica, 480 pF ±1%, 500V	182931	71236	DM19E481F	1		
C155	Cap, fxd, mica, 2200 pF ±5%, 500V	148346	71236	DM19F222J	1		
C157	Cap, fxd, mica, 27 pF ±5%, 500V	177998	71236	DM15E270J	1		
C159	Cap, fxd, mica, 4700 pF ±5%, 500V	208975	71236	DM19F472J	1		
C174, C185	Cap, fxd, cer, 0.1 uF −20/+80% 500V	105684	56289	41C92	2		
C175	Cap, fxd, elect, 50 uF −10/+75%, 50V	105122	56289	30D505G050BC	1	1	
C180, C193	Cap, fxd, MTL Polyester, 0.01 uF ±20%, 4KV	403048	84411	X663F010204K V	2		
C181	Cap, fxd, cer, 100 pF ±20%, 2KV	306357	04222	HVD4-100202K V1	1		
C182, C183	Cap, elect, 220 uF −10/+50%, 40V	178616	73445	ET221X040A01	2	1	
C192	Cap, fxd, ceram, 47 pF ±10%, 2KV	282145	04222	HVD3-47102KV	1		

Table 5-6. Pre Amp PCB Assembly (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR35, CR36, CR53, CR54, CR103 thru CR106, CR125, CR126, CR132, CR151, CR152, CR157, CR183, CR185, CR192, CR202 thru CR209	Diode, Hi-Speed, Switching	203323	07910	1N448	25	5	
CR70, CR175, CR182	Diode, Rectifier Bridge	296509	09423	FB200	3	1	
CR92, CR121 thru CR124, CR154, CR155	Diode, Si, Low Cap	375907	07263	FD7222	7	2	
CR101, CR102	Diode, Si, Schottky Barrier Switching	313247	51174	HP5082-6264	2	1	
J24, J25, J26	Conn, Coax	394239	98291	51-151-0000	3		
L11, L12, L85, L86	Choke, 6 Turn	320911	89536	320911	4		
Q7, Q121	Xstr, FET, D-MOS, N-Channel	394122	18324	SD210	2	1	

Table 5-6. Pre Amp PCB Assembly (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q37, Q42, Q44, Q45, Q77, Q101, Q102, Q103, Q106, Q147	Xstr, Si, PNP	195974	04713	2N3906	10	2	
Q40, Q51, Q92, Q93 Q105, Q138, Q161, Q176, Q183, Q184, Q185	Xstr, Si, NPN	218396	04713	2N3904	11	3	
Q43	Xstr, Si, NPN	329698	07263	2N2484	1	1	
Q62	Xstr, Si, NPN	203489	07910	CDQ10656	1	1	
Q76	Xstr, Si, PNP, Power	325753	03508	D45C5	1	1	
Q79	Xstr, Si, NPN, Power	325761	03508	D44C5	1	1	
Q104	Xstr, Si, NPN	295717	24355	00117	1	1	
Q128	Xstr, FET, Junction, N-Channel	288324	12040	SF50070	1	1	
Q132	Xstr, Si, PNP	229898	04713	MPS6522	1	1	
Q140	Xstr, Si, NPN	333898	04713	MPSH10	1	1	
Q148	Xstr, Si, PNP	392985	07263	2N3931	1	1	
Q177, Q182, Q186, Q187	Xstr, Si, NPN	346916	07263	2N2219A	4	1	
R1, R2	Res, fxd, comp, 750 ±5%, ¼W	218024	01121	CB7515	2		

Table 5-6. Pre Amp PCB Assembly (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R3, R41, R44, R92, R97	Res, fxd, comp, 1.5K ±5%, ¼W	148031	01121	CB1525	5		
R6	Res, fxd, met film, 49.9K ±1%, 1/8W	268821	91637	MFF1-84992F	1		
R7	Res, fxd, met film, 5.23K ±1%, 1/8W	268821	91637	MFF1-85231F	1		
R8	Res, fxd, met film, 71.5K ±1%, 1/8W	291435	91637	MFF1-87152F	1		
R9, R123	Res, var, cer, 200K ±10%, ½W	381921	32997	3299W-1-204	2		
R11	Res, fxd, comp, 27K ±5%, ¼W	148148	01121	CB2735	1		
R12, R83,	Res, fxd, comp, 51K ±5%, ¼W	193334	01121	CB5135	2		
R14	Res, fxd, met film, 1K ±1%, 1/8W	168229	91637	MFF1-81001F	1		
R15	Res, fxd, met film, 2.55K ±1%, 1/8W	325498	91637	MFF1-82551F	1		
R21	Res, fxd, met film, 14K ±1%, 1/8W	379057	91637	MFF1-81402F	1		
R23	Res, fxd, met film, 8.06K ±1%, 1/8W	294942	91637	MFF1-88061F	1		
R24	Res, fxd, met film, 6.98K ±1%, 1/8W	261685	91637	MFF1-86981F	1		
R25	Res, fxd, met film, 15K ±1%, 1/8W	328161	91637	MFF1-81502F	1		
R26, R197	Res, fxd, met film, 806 ±1%, 1/8W	223662	91637	MFF1-88060F	2		
R27, R28, R137, R158, R190	Res, fxd, comp, 1M ±5%, ¼W	182204	01121	CB1055	5		
R29, R48, R159, R164	Rex, fxd, comp, 10K ±5%, ¼W	148106	01121	CB1035	4		
R35, R45	Rex, fxd, comp, 68K ±5%, ¼W	148171	01121	CB6835	2		
R36	Res, fxd, comp, 220K ±5%, ¼W	160937	01121	CB2245	1		

Table 5-6. Pre Amp PCB Assembly (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R37, R93, R203	Res, fxd, comp, 4.7K ±5%, ¼W	148072	01121	CB4725	3		
R38, R53, R54, R136	Res, fxd, comp, 220 ±5%, ¼W	147959	01121	CB2215	4		
R40, R127	Res, fxd, comp, 47K ±5%, ¼W	148163	01121	CB4735	2		
R42, R46, R47, R75, R121, R128, R185, R191	Res, fxd, comp, 100 ±5%, ¼W	147926	01121	CB1015	8		
R43, R52	Res, fxd, comp, 22K ±5%, ¼W	148130	01121	CB2235	2		
R49	Res, fxd, comp, 2.2K ±5%, ¼W	148049	01121	CB2225	1		
R50	Res, fxd, comp, 1.2K ±5%, ¼W	190371	01121	CB1225	1		
R51	Res, fxd, comp, 5.6K ±5%, ¼W	148080	01121	CB5625	1		
R59, R91	Res, fxd, met film, 9.53M ±1%, 1W	394098	91637	MFF1-89534F	2		
R60	Res, fxd comp, 2K ±5%, ¼W	169854	01121	EB2025	1		
R61, R62	Res, fxd, comp, 1.2K ±5%, 1W	109892	01121	CB1225	2		
R63, R66	Res, fxd, met film, 10K ±1%, 1/8W	168260	91637	MFF1-81002F	2		
R64, R65	Res, fxd, met film, 20K ±1%, 1/8W	291872	91637	MFF1-82002F	2		
R67	Res, fxd met film, 56.2K ±1%, 1/8W	271346	91637	MFF1-85622F	1		
R72	Res, fxd, comp, 120K ±5%, ¼W	193458	01121	CB1245	1		
R73, R74, R133, R134, R136	Res, fxd, met film, 7.5K ±1%, 1/8W	223529	91637	MFF1-87501F	5		

Table 5-6. Pre Amp PCB Assembly (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R76	Res, fxd, comp, 2K ±5%, ¼W	202879	01121	CB2025	1		
R77	Res, fxd, comp, 8.2 ±5%, ¼W	246751	01121	CB82G5	1		
R78	Res, fxd, comp, 2.4K ±5%, ¼W	193433	01121	CB2425	1		
R79	Res, fxd, comp, 3.9 ±5%, ¼W	268722	01121	CB39G5	1		
R80	Res, fxd, met film, 5.11K ±1%, 1/8W	294868	91637	MFF1-85111F	1		
R81	Res, fxd, met film, 4.22K ±1%, 1/8W	168245	91637	MFF1-84221F	1		
R82, R154	Res, var, cer, 1K ±10%, ½W	275750	71450	360T102A	2		
R94, R95, R140, R141, R151	Res, fxd, comp, 1K ±5%, ¼W	148023	01121	CB1025	5		
R96, R106, R107, R157	Res, fxd, met film, 1.5K ±1%, 1/8W	313098	91637	MFF1-81501F	4		
R98	Res, fxd, comp, 33K ±5%, ¼W	148155	01121	CB3335	1		
R101, R102, R143, R193	Res, fxd, met film, 1.82K ±1%, 1/8W	293670	91637	MFF1-81821F	4		
R103	Res, mxd, met film, 3.01K ±1%, 1/8W	312645	91637	MFF1-83011F	1		
R104, R105	Res, fxd, met film, 40.2 ±1%, 1/8W	245373	91637	MFF1-840R2F	2		
R108	Res, fxd, met film, 147 ±1%, 1/8W	288415	91637	MFF1-81470F	1		
R109	Res, fxd, met film, 267 ±1%, 1/8W	386821	91637	MFF1-82670F	1		
R110	Res, fxd, met film, 2.37K ±1%, 1/8W	293720	91637	MFF1-82371F	1		
R111	Res, var, cer, 100 ±10%, ½W	275735	11236	360T101AZ	1		
R122	Res, fxd, met film, 150K ±1%, 1/8W	241083	91637	MFF1-81503F	1		
R124	Res, fxd, met film, 10 ±1%, 1/8W	268789	91637	MFF1-8A100F	1		
R125	Res, fxd, comp, 5.1K ±5%, ¼W	193342	01121	CB5125	1		
R126, R129	Ref, fxd, met film, 1.91K ±1%, 1/8W	236877	91637	MFF1-81911F	2		
R130	Res, var, cer, 500 ±10%, ½W	325613	11236	360T501AZ	1		

Table 5-6. Pre Amp PCB Assembly (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R132	Res, fxd, comp, 3.9K ±5%, ¼W	148064	01121	CB3925	1		
R135	Res, fxd, comp, 1.3K ±5%, ¼W	234252	01121	CB1325	1		
R138	Res, fxd met film, 3.74K ±1%, 1/8W	272096	91637	MFF1-83741F	1		
R139	Res, fxd, comp, 10K ±10%, 1W	109389	01121	GB1031	1		
R142, R155	Res, fxd, comp, 15K ±5%, ¼W	148114	01121	CB1535	2		
R144, R146	Res, fxd, met film, 8.25K ±1%, 1/8W	294959	91637	MFF1-88251F	2		
R147	Res, fxd, met film, 100K ±1%, 1/8W	340166	91637	MFF1-81003F	1		
R151	Res, fxd, comp, 5.6M ±5%, ¼W	358077	01121	CB5655	1		
R152, R153	Res, fxd, comp, 1M ±5%, 2W	268227	01121	HB1011	2		
R160	Res, fxd, comp, 150K ±5%, ¼W	182212	01121	CB1545	1		
R161	Res, fxd, comp, 680 ±5%, ¼W	148007	01121	CB6815	1		
R162, R177	Res, fxd, comp, 510 ±5%, ¼W	218032	01121	CB5115	2		
R163	Res, fxd, comp, 39 ±5%, ¼W	193391	01121	CB3905	1		
R165	Res, fxd, comp, 510 ±5%, ½W	108951	01121	EB5115	1		
R166	Res, fxd, comp, 910 ±5%, ¼W	203851	01121	CB9115	1		
R167	Res, fxd, met film 590 ±1%, 1/8W	261883	91637	MFF1-85900F	1		
R170 thru R174	Res, fxd, met film, 200K ±1%, 1W	387449	91637	MFF1-2003F	5		
R175	Res, fxd, comp, 200 ±5%, 1W	190603	01121	GB2015	1		
R176	Res, fxd, comp, 1.5K ±5%, ½W	266353	01121	EB1525	1		
R178, R179, R184, R186	Res, fxd, comp, 270 ±5%, ¼W	160804	01121	CB2715	4		
R180	Res, fxd, comp, 51 ±5%, ¼W	221879	01121	CB5105	1		
R181	Res, fxd, comp, 10 ±5%, ¼W	147868	01121	CB1035	1		
R182, R183	Res, fxd, comp, 680K ±10%, 1W	109694	01121	GB6811	2		

Table 5-6. Pre Amp PCB Assembly (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R192	Rex, fxd, comp, 2.7K ±5%, ½W	109074	01121	EB2725	1		
R194, R202	Rex, fxd, met film, 2.43 ±1%, 1/8W	312637	91637	MFF1-82341F	2		
R195	Res, fxd, met film, 49.9 ±1%, 1/8W	305896	91637	MFF1-849R9F	1		
R196	Res, fxd, met film, 249 ±1%, 1/8W	168203	91637	MFF1-82490F	1		
R198	Res, fxd, met film, 121K ±1%, 1/8W	229396	91637	MFF1-81213F	1		
R199	Res, fxd, comp, 820 ±5%, 1W	266379	01121	GB8215	1		
R201	Res, fxd, comp, 620 ±5%, ½W	108704	01121	EB6215	1		
R204	Res, fxd, comp, 100K ±5%, 2W	285056	01121	HB1045	1		
R205, R206, R207	Res, fxd, comp, 200K ±5%, 2W	392696	01121	HB2245	3		
R301	Res, met film, 10K ±1%, ½W	151274	91637	MFF1-21002F	1		
R302	Res, met film, 1M ±1%, 1W	177188	91637	MFF11004F	1		
R303, R304	Assy, Resistor, Divider	401372	89536	401372	1	1	
U7	IC, Op Amp Linear	329912	12040	LM318H	1	1	
U12	IC, Op Amp, Fast Setting	403063	24355	AD509J	1	1	
U51, U52	Op to, Isolator, Xstr	387076	50579	ISO-LIT-D74	2	1	
U62	Op to, Isolator, Xstr	380014	01295	TIL116	1	1	
U64, T65, U167	IC, Linear, Vol Comparator	352195	12040	LM311N	3	1	
U75, U157	IC, Op, Amp	271502	12040	LM301A	2	1	
U79	IC, Linear, Vol Regulator	313106	07263	USR7723393	1	1	
U123	IC, Linear, Op Amp	418368	12040	LM208A	1	1	
U160	Op to, Isolator, Xstr	393900	07374	OPI1078	1	1	
VR1, VR2, VR199	Diode, Zener	277236	07910	1N752A	3	1	

Table 5-6. Pre Amp PCB Assembly (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
VR76	Diode, zener	113332	07910	1N966A	1	1	
VR94	Diode, zener	113316	07910	1N748	1	1	
VR132	Diode, zener	342527	07910	333719	1	1	
VR152	Diode, zener	353284	12969	UZ8113	1	1	
VR166, VR202	Diode, zener	172148	12065	1N3496	2	1	
VR174	Diode, zener	358184	12969	UZ8112	1	1	
VR176	Diode, zener	159780	07910	1N759	1	1	
VR182	Diode, zener	387092	07910	1N975A	1	1	
VR185	Diode, zener	358176	12969	UZ8110	1	1	
VR193	Diode, zener	386839	04713	1N5388	1	1	
XU12	Socket, IC, 8-pin	408450	*	A23-2017	1		
	Conn, card edge, modified	408005	00779	583694-9	3		
	Heat sink (Q177)	104646	05820	207-AB	1		
	Heat sink (Q182)	104562	05820	NF-209	1		
	Heat sink (Q79)	407890	98978	PA1-1R	1		
	Retainer, guide	339754	89536	339754	3		
	Spacer, Mtg, xstr	152207	07047	10123DAP	8		
	PCB Assembly, Zener String (Figure 8-6b)						
VR1 thru VR9	Diode, zener, uncomp, 50V	386839	04713	1N5388B	9	2	
VR10	Diode, zener, uncomp, 100V	358176	12969	UZ8110	1	1	
VR11	Diode, zener, uncomp, 200V	358150	12969	UZ8750	1	1	
*	Manufactured By: Jermyn 712 Montgomery San Francisco, CA 94111						

Table 5-7. PCB Assembly Amp Tube Anode

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	PCB ASSY, PRE AMP, TUBE ANODE (Figure 8-6c)	397281	89536	397281	REF		
R1,R2, R3,R4	Res, fxd, met film 150K ±0.5%, 1W	393397	91637	MFF1-11503D	4		
V1,V2	Tube, vacumn	339762	06980	7034-4X150A	2	2	
XV1, XV2	Socket, Tube, loctal	340927	13511	88-8X	2		
	Clamp, cap mtg	357715	56289	4586-97B	2		
	Cover, driver shield	349548	89536	349548	1		
	Plug, probe	295295	98291	011-4017	1		
	Retainer, guide	339754	89536	339754	1		

Table 5-8. Power Amplifier Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	ASSY; POWER AMP (Figure 5-12)	341511	89536	341511	1		
1	PCB Assy, Power Amp, Upper Tube (Refer to Table 5-9)	336875	89536	336875	1		
2	PCB Assy, Power Amp, Lower Tube (Refer to Table 5-10)	336800	89536	336800	1		
3	PCB Assy, Power Amp, Lower Tube Screen Regulator (Refer to Table 5-11)	362137	89536	362137	1		
4	PCB Assy, Power Amp, Tube Mounting (Refer to Table 5-12)	336834	89536	336834	1		
5	Cable Assy, Power Amp Input	346551	89536	346551	1		
	Cable, coax RG188A/U	190322	70903	8269	6 in.		
	Probe, Teflon, yellow	295295	98291	011-4017	2		
6	Decal	360545	89536	360545	1		
7	Insulator	338608	89536	338608	1		
8	Shield, Front	336750	89536	336750	1		
9	Shield, Rear	337428	89536	337428	1		

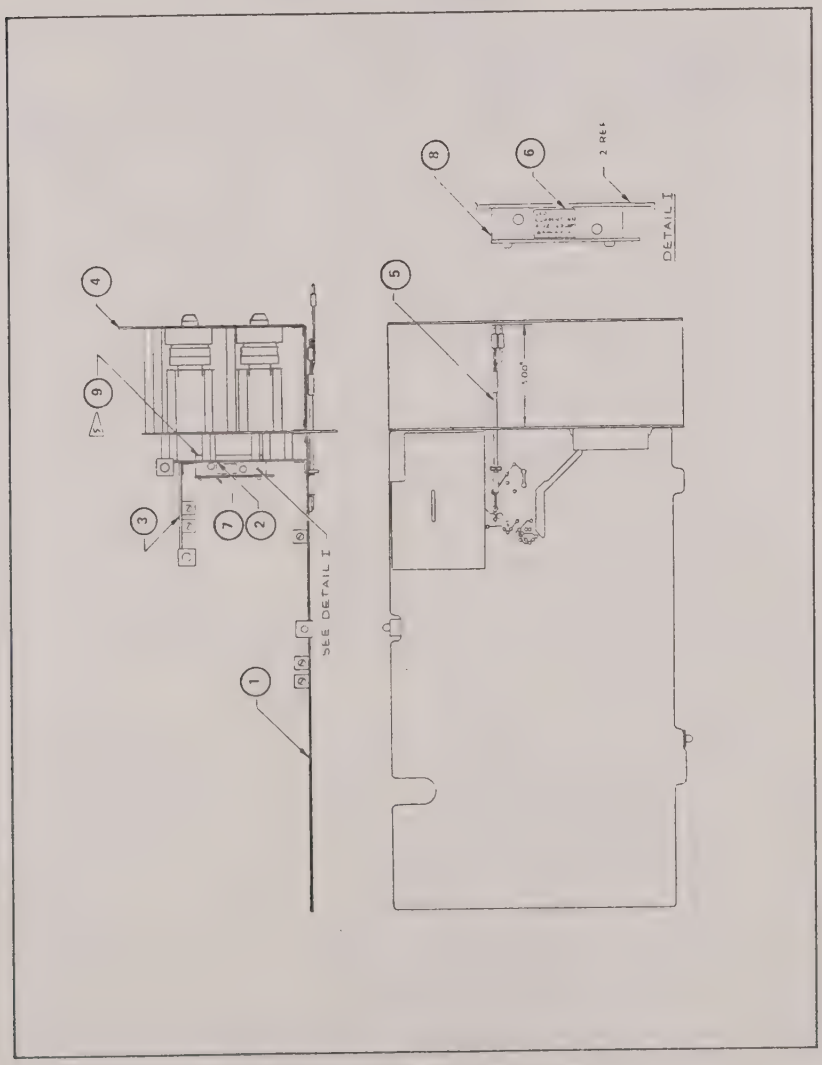


Figure 5-12. Power Amplifier Assembly Locations

Table 5-9. PCB Assembly, Power Amp Upper Tube

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	PCB ASSY, POWER AMP, UPPER TUBE (Figure 8-8)	336875	89536	336875	REF		
C2	Cap, fxd, mica, 12 pF ±5%, 500V	175224	71236	DM15C 120J	1		
C4	Cap, fxd, mica, 4pF ±5%, 500V	190397	71236	DM15C040J	1		
C8	Cap, fxd, cer, 0.05 uF −20/+80%, 25V	148924	72982	5855Y5U5032	1		
C10,C11	Cap, fxd, mica, 510 pF ±5%, 500V	148411	71236	DM19E511J	2		
C25	Cap, elect, 2200 uF −10/+100%, 25V	392720	99392	39CS25HJ252	1	1	
C26, C41	Cap, fxd, polyester 0.047 uF ±10%, 250V	162008	73445	C280MAE/A47K	2		
C27	Cap, fxd, Ta, 6.8 uF ±20%, 35V	363713	56289	196D685X0035	1		
C28,C39	Cap, fxd, plstc, 0.0047 uF ±10%, 50V	260844	06001	75F1R5A472	2		
C30,C37	Cap, fxd, cer, 4700 pF ±10%, 500V	106724	71590	CF472	2		
C42 C43	Cap, fxd, elect, 10 uF −10,+50%, 300V	340885	56289	500D106F300D C	2	1	
CR1 thru CR4, CR18, CR28, CR29, CR36, CR37	Diode, Hi-speed switching	203323	07910	1N448	9		
CR5, CR7 thru CR10	Diode, FET, Cur, Reg	334714	07910	TCR5315	5	2	
CR6	Diode, FET, current regulator	284927	01295	TCR5305	1	1	
CR25	Rectifier, bridge	296509	09423	FB200	1	1	
CR42, CR43	Diode, Si, 1 amp	112383	05277	1N4822	2	1	
K1,K2	Reed, switch	184440	12617	DRVT-10	2		
	Coil, Reed Relay	387258	71707	SP24HP	2		
	Foil Shield	336685	89536	336685	2		
L12	Choke, 4 turn	379222	89536	379222	1		
L14	Choke, 2 turn	417196	89536	417196	1		

Table 5-9. PCB Assembly, Power Amp Upper Tube (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
L17	Choke, 6 turn	320911	89536	320911	1		
P34	Conn, plug, 15 pin	310094	27264	03-09-2151	1		
	Pin, Terminal	342998	27264	02-09-2133	7		
Q4	Xstr, FET, N-channel junction	387050	12040	SF51108	1	1	
Q8	Xstr, Si, NPN	242065	04713	2N5089	1	1	
Q11	Xstr, Si, NPN, pwr	343970	04713	MPS-U06	1	1	
Q12	Xstr, Si, PNP, pwr	343988	04713	MPS-U56	1	1	
Q14	Xstr, NPN, Hi-voltage	393926	04713	MM3008	1	1	
Q16	Xstr, Si, NPN	218396	04713	2N3904	1	1	
Q17, Q18	Xstr, Si, PNP	329607	07263	2N3964	2	1	
Q26, Q40	Xstr, Si, NPN	218511	95303	40327	2	1	
R2	Res, fxd, comp, 100K ±10%, 1W	109397	01121	GB1041	1		
R7	Res, var, cer, 500 ±10%, ½W	291120	71450	360S-501A	1	1	
R8	Res, fxd, comp, 470 ±5%, ¼W	147983	01121	CB4715	1		
R9	Res, fxd, comp, 1.5K ±5%, ¼W	148031	01121	CB1525	1		
R10, R11, R27	Res, fxd, comp, 100 ±5%, ¼W	147926	01121	CB1015	3		
R12, R13	Res, fxd, comp, 10 ±10%, ½W	108092	01121	EB1001	2		
R14, R15	Res, fxd, comp, 1.5M ±10%, 1W	109439	01121	GB1551	2		
R16	Res, fxd, comp, 10K ±5%, ¼W	148106	01121	CB1035	1		
R18	Res, fxd, met film, 137 ±1%, ½W	151142	91637	MFF1-21370F	1		
R19	Res, fxd, comp, 1M ±10%, 2W	268227	01121	HB1051	1		
R24, R34	Res, fxd, met film, 22.6K ±1%, 1/8W	288431	91637	MFF1-82262F	2		
R25, R41	Res, fxd, comp, 33 ±5%, ¼W	175034	01121	CB3305	2		
R26, R40	Res, fxd, comp, 8.2K ±5%, 2W	330555	01121	HB8225	2		

Table 5-9. PCB Assembly, Power Amp Upper Tube (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R28, R39	Res, fxd, comp, 5.6K ±5%, ¼W	148080	01121	CB5625	2		
R29, R36	Res, fxd, met film, 14.3K ±1%, 1/8W	291617	91637	MFF1-81432F	2		
R30, R37	Res, fxd, met film, 499K ±1%, ½W	151332	91637	MFF1-24993F	2		
R31, R38	Res, fxd, ww, pwr 40K ±5%, 10W	392688	91637	CW104002J	2		
R32	Res, fxd, met film, 1.21K ±1%, 1/8W	229146	91637	MFF1-81211F	1		
R33 R35	Res, var, cermet, 5K ±10%, ½W	355503	11236	362S502AZ	2	1	
R42, R43, R44	Res, fxd, pwr, 27 ±5%, 3W	393413	91637	Type FP37	3		
R45	Res, fxd, comp, 270 ±5%, ¼W	160804	01121	CB2715	1		
T43	Xfmr	401380	89536	401380	1		
U28, U39	IC, Op, Amp	271502	12040	LM301A	2	1	
VR13, VR26, VR41	Diode, zener	159798	07910	1N748	3	1	
VR14	Diode, zener	386995	04713	1N5335B	1	1	
VR15	Diode, zener	355073	12969	UZ8708	1	1	
VR19	Diode, zener	407825	12969	UZ8740	1	1	
VR33	Diode, zener	172148	12065	1N3496	1	1	
VR37 thru VR40	Diode, zener	358184	12969	UZ8112	4	1	
XQ17	Socket, Xstr	285262	71785	133-23-92-039	1		
	Guide, retainer	341099	89536	341099	2		
	Heat sink (Q4 & Q17)	354993	98978	TXC20CB	2		
	Heat sink (Q14)	104562	05820	NF-209	1		
	Heat sink (Q11)	349019	98978	LP-TO126-83CB	1		
	Heat sink (Q12)	407890	98978	PA1-1R	1		

Table 5-9. PCB Assembly, Power Amp Upper Tube (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Heat sink (Q26 & Q40)	104646	05820	207-AB	2		
	Jack, Horizontal, conn	149112	74970	105-0753	4		
	Safety, guard	402040	89536	402040	1		
	Transipad, xstr (Q14, Q26 & Q40)	152207	07047	10123DAP	3		

Table 5-10. PCB Assembly, Power Amp Lower Tube

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	PCB ASSY, POWER AMP LOWER TUBE (Figure 8-10a)	341586	89536	341586	REF		
C50, C185	Cap, fxd, plstc, 0.047 uF ±20%, 4KV	393389	56289	430P	2		
C162	Cap, var, cer, 5 - 50 pF ± 250V	404301	91293	9335	1		
C170	Cap, fxd, mica, 33 pF ±5%, 500V	160317	71236	DM15E330J	1		
C171	Cap, fxd, Ta, 0.22 uF ±20%, 35V	161331	56289	196D224X0035 HA1	1		
C180	Cap, elect, 220 uF −10/+50%, 40V	178616	73445	ET221X040A01	1	1	
C181	Cap, elect, 1000 uF −10/+100%, 40V	340901	99392	39C40HH13	1	1	
C182 C183	Cap, fxd, Ta, 6.8 uF ±20%, 35V	363713	56289	196D685X0035 HA1	2		
CR158 CR160 CR170	Diode, Hi-speed switching	203323	07910	1N448	3	1	
CR180	Rectifier, bridge	296509	09423	FB200	1	1	
J32	Conn, board edge recpt, 6	291625	00779	583650-1	1		
J37	Conn, board edge recpt, 10	403964	00779	583407-6	1		
L50, L185	Choke, 4 turn	379222	89536	379222	2		
L155	Inductor, sub-mint	249078	24759	MR10	1		
L182, L183	Choke, 6 turn	320911	89536	320911	2		
Q150	Xstr, Si, NPN	343970	04713	MPS-U06	1	1	
Q155, Q161	Xstr, FET, N-Channel	403089	12040	SF58014	2	1	
Q158	Xstr, Si, PNP	195974	04713	2N3906	1	1	
Q160	Xstr, Si, PNP	329607	07263	2N3964	1	1	
Q165	Xstr, Si, NPN	242065	04713	2N5089	1	1	
R80, R155	Res, fxd, comp, 10 ±5%, 1W	166298	01121	GB1005	2		
R151	Res, fxd, met film, 10 ±1%, ½W	151043	91637	MFF1-210R0F	1		

Table 5-10. PCB Assembly, Power Amp Lower Tube (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R152	Res, fxd, comp, 2.7K ±5%, ½W	109074	01121	DB2725	1		
R155	Res, fxd, comp, 510 ±5%, 1W	157578	01121	GB5115	1		
R156	Res, fxd, comp, 4.3K ±5%, ½W	403337	01121	DB4325	1		
R157, R174	Res, fxd, comp, 1K ±5%, ¼W	148023	01121	CB1025	2		
R158	Res, fxd, comp, 3.3K ±5%, ¼W	148056	01121	CB3325	1		
R160	Res, fxd, met film, 422 ±1%, ½W	150821	91637	MFF1-24220F	1		
R161	Res, fxd, comp, 39 ±5%, ¼W	193391	01121	CB3905	1		
R162	Res, fxd, comp, 5.1K ±5%, ½W	109108	01121	EB5125	1		
R170	Res, fxd, met film, 10K ±1%, 1/8W	168260	91637	MFF1-81002F	1		
R171	Res, fxd, met film, 59K ±1%, 1/8W	261677	91637	MFF1-85902F	1		
R172	Res, var, cermet, 2K ±10%, ½W	285163	71450	360S202A	1		
R173	Res, fxd, met film, 909 ±1%, 1/8W	312629	91637	MFF1-89090F	1		
R175	Res, fxd, comp, 2.4K ±5%, ½W	108902	01121	DB2425	1		
U165	Opto - Coupler	351734	89536	351734	1	1	
U170	IC, Op Amp	271502	12040	LM301A	1	1	
VR156	Diode, zener	340695	12969	UZ8710	1	1	
VR159	Diode, zener	260695	07910	1N754	1	1	
VR161	Diode, zener	246611	07910	1N961B	1	1	
VR175	Diode, zener	172148	12065	1N3496	1	1	
	Guide	341099	89536	341099	1		
	Heat sink (Q150)	349019	98978	UP-TO126-83CB	1		

Table 5-11. PCB Assembly, Lower Tube Screen Regulator

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	PCB ASSY, LOWER TUBE SCREEN REGULATOR (Figure 8-10b)	362137	89536	362137	REF		
C101, C102	Cap, elect, 10 uF −10/+50%, 300V	340885	56289	500D106F300D C7	2	1	
C103, C117	Cap, fxd, polyester 0.047 uF ±10%, 250V	162008	73445	C280MAE/A47K	2		
C104	Cap, fxd, Ta, 6.8 uF ±20%, 35V	363713	56289	196D685X0035	1		
C105, C114	Cap, fxd, cer 0.0047 uF ±10%, 1KV	106724	71590	CF472	2		
C106, C115	Cap, fxd, plstc, 0.0047 uF ±10%, 50V	260844	06001	75F1R5A472	2		
CR101 CR102	Diode, Si, 2 Amp	112383	05277	1N4822	2	1	
CR104, CR110, CR113 CR114	Diode, Hi-speed switchng	203323	07910	1N448	4	2	
Q101, Q116	Xstr, Si, NPN	218511	95303	65120	2	1	
R101, R116	Res, fxd, comp, 8.2K ±5%, 2W	330555	01121	HB8225	2		
R102, R117	Res, fxd, comp, 33 ±5%, ¼W	175034	01121	CB3305	2		
R103	Res, fxd, comp, 100 ±5%, ¼W	147926	01121	CB1015	1		
R104, R108	Res, fxd, pwr, ww, 40K ±5%, 10W	392688	91637	CW10X000D40 R00J	2		
R105, R114	Res, fxd, met film, 499K ±1%, ½W	151332	91637	MFF1-24993F	2		
R106, R115	Res, fxd, comp, 5.6K ±5%, ¼W	148080	01121	CB5625	2		
R107	Res, fxd, met film, 2.26K ±1%, ½W	262006	91637	MFF1-22261F	1		
R109, R112	Res, var, cermet, 5.0K ±10%, ½W	355503	11236	362S502	2		
R110, R113	Res, fxd, met film, 14.3K ±1%, 1/8W	291617	91637	MFF1-81432F	2		

Table 5-11. PCB Assembly, Lower Tube Screen Regulator (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R111, R118	Res, fxd, met film, 22.6K ±1%, 1/8W	288431	91637	MFF1-82262	2		
U101, U114	IC, Op Amp	271502	18324	LM301A	2	1	
VR103, VR117	Diode, zener	159798	07910	1N751A	2	1	
VR105, VR106, VR107, VR108	Diode, zener	358184	12969	UZ8112	4	1	
VR112	Diode, zener	172148	12065	1N3496	1	1	
	Guide, Retainer	341099	89536	341099	1		
	Heat sink	104646	90372	207AB	2		
	Transipad, xstr	152207	07047	10123DAP	2		

Table 5-12. PCB Assembly, Power Amp Tube Mounting

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	PCB ASSY, POWER AMP TUBE MOUNTING (Figure 8-10c)	336834	89536	336834	REF		
J38	Conn, receptacle	404053	00779	583694-8	1		
R201, R208, R221, R225, R229, R230	Res, fxd, comp, 200 ±5%, ½W	169839	01121	EB2015	6		
R202, R207	Res, fxd, comp, 47 ±5%, ½W	159608	01121	EB4705	2		
R203, R206, R231, R232	Res, fxd, comp, 1.5M ±10%, 1W	109439	01121	GB1551	4		
R204, R205, R224, R226	Res, fxd, met film, 10 ±1%, ½W	151043	91637	MFF1-2A100F	4		
R222, R223, R227, R228	Res, fxd, power, 360 ±5%, 3W	393405	91637	TYPEFP37	4		
V1,V2, V3,V4	Tube, vacuum, Tetrode	339762	08594	4X150A	4	4	
XV1, XV2, XV3, XV4	Socket, tube	340927	02660	88-8X	4		
	Baffle, pwr Amp board	341727	89536	341727	1		
	Baffle, pwr Amp	400796	89536	400796	1		
	Guide, Retainer	341099	89536	341099	1		

Section 6
Option & Accessory Information

6-1. INTRODUCTION

6-2. This section of the manual contains information pertaining to the accessories and options available for the 5205A.

6-3. ACCESSORY INFORMATION

6-4. A rack mounting kit, Model No. M10-205-600, is available for the 5205A. Instructions for use accompany the kit.

6-5. OPTION —07, REAR PANEL OUTPUT

6-6. Option —07 provides a rear panel output connector for use in system applications. The output cable is routed out the rear panel and the hole plug moved from the rear to front panels. The repositioning shortens the length of output cable available from three feet to approximately two feet. Operation of the instrument and all other parts are identical with the Standard front panel output version.

Section 7
General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

List of Abbreviations and Symbols

A or amp	ampere
ac	alternating current
af	audio frequency
a/d	analog-to-digital
assy	assembly
AWG	american wire gauge
B	bel
bcd	binary coded decimal
°C	Celsius
cap	capacitor
ccw	counterclockwise
cer	ceramic
cermet	ceramic to metal(seal)
ckt	circuit
cm	centimeter
cmrr	common mode rejection ratio
comp	composition
cont	continue
crt	cathode-ray tube
cw	clockwise
d/a	digital-to-analog
dac	digital-to-analog converter
dB	decibel
dc	direct current
dmm	digital multimeter
dvm	digital voltmeter
elect	electrolytic
ext	external
F	farad
°F	Fahrenheit
FET	Field-effect transistor
ff	flip-flop
freq	frequency
FSN	federal stock number
g	gram
G	giga (10^9)
gd	guard
Ge	germanium
GHz	gigahertz
gmv	guaranteed minimum value
gnd	ground
H	henry
hd	heavy duty
hf	high frequency
Hz	hertz
IC	integrated circuit
if	intermediate frequency
in	inch(es)
intl	internal
I/O	input/output
k	kilo (10^3)
kHz	kilohertz
kΩ	kilohm(s)
kV	kilovolt(s)
lf	low frequency
LED	light-emitting diode
LSB	least significant bit
LSD	least significant digit
M	mega (10^6)
m	milli (10^{-3})
mA	milliampere(s)
max	maximum
mf	metal film
MHz	megahertz
min	minimum
mm	millimeter
ms	millisecond
MSB	most significant bit
MSD	most significant digit
MTBF	mean time between failures
MTTR	mean time to repair
mV	millivolt(s)
mv	multivibrator
MΩ	megohm(s)
n	nano (10^{-9})
na	not applicable
NC	normally closed
(–) or neg	negative
NO	normally open
ns	nanosecond
opnl ampl	operational amplifier
p	pico (10^{-12})
para	paragraph
pcb	printed circuit board
pF	picofarad
pn	part number
(+) or pos	positive
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
PROM	programmable read-only memory
psi	pound-force per square inch
RAM	random-access memory
rf	radio frequency
rms	root mean square
ROM	read-only memory
s or sec	second (time)
scope	oscilloscope
SH	shield
SI	silicon
serno	serial number
sr	shift register
Ta	tantalum
tb	terminal board
tc	temperature coefficient or temperature compensating
tcxo	temperature compensated crystal oscillator
tp	test point
u or μ	micro (10^{-6})
uhf	ultra high frequency
us or μs	microsecond(s) (10^{-6})
uut	unit under test
V	volt
v	voltage
var	variable
vco	voltage controlled oscillator
vhf	very high frequency
vlf	very low frequency
W	watt(s)
ww	wire wound
xfmr	transformer
xstr	transistor
xtal	crystal
xtlo	crystal oscillator
Ω	ohm(s)
μ	micro (10^{-6})

Federal Supply Codes for Manufacturers

00213
Nytronics Comp. Group Inc
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc
Westlake, Ohio

00656
Aerovox Corp
New Bedford, Massachusetts

00686
Film Capacitors, Inc
Passaic, New Jersey

00779
AMP Inc
Harrisburg, Pennsylvania

01121
Allen-Bradley Co
Milwaukee, Wisconsin

01281
TRW Electronic Comp
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc
Franklin Park, Illinois

01686
RCL Electronics Inc
Manchester, New Hampshire

01730
Replaced by 73586

01884
Use 56289
Sprague Electric Co.
Dearborn Electronic Div
Lockwood, Florida

02114
Ferroxcube Corp
Saugerties, New York

02131
General Instrument Corp
Harris ASW Div
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Sneigrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 3M2

02636
Fenwal Labs
Div. of Travenal Labs
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div
Formerly Amphenol-Borg
Electric Corp
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products
Syracuse, New York

03614
Replaced by 71400

03651
Replaced by 44655

03797
Eidema Div.
Genisco Technology Corp
Compton, California

03877
Transistron Electronic Corp
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp
Whippany, New Jersey

03911
Clairex Electronics Div
Clairex Corp
Mt. Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

04217
Essex International Inc
Wire & Cable Div
Anaheim, California

04221
Aemco, Div. of
Midtex Inc
Mankato, Minnesota

04222
AVX Ceramics Div
AVX Corp
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04948
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc.
Chicago, Illinois

05277
Westinghouse Electric Corp
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp
Materials Systems Div.
New York, New York

05571
Use 56289
Sprague Electric Co
Pacific Div
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co
Electronic Capacitor &
Battery Products Dept
Columbia, South Carolina

06136
Replaced by 63743

06383
Panduit Corp
Tinley Park, Illinois

06473
Bunker Ramo Corp
Amphenol SAMS Div
Chatsworth, California

06555
Beede Electrical Instrument Co
Penacook, New Hamoshire

06739
Electron Corp
Littleton, Colorado

06743
Clevite Corp
Cleveland, Ohio

06751
Components, Inc. Semcor Div
Phoenix, Arizona

06860
Gould Automotive Div
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div
Bedford, Ohio

06980
Eimac Div
Varian Associates
San Carlos, California

07047
The Ross Milton Co
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Div
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp
Div. of BBF Group Inc
Chelmsford, Massachusetts

07261
Aumet Corp
Culver City, California

07263
Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp
Mountain View, California

07344
Bircher Co., Inc
Rochester, New York

07597
Burndy Corp
Tape Cable Div
Rochester, New York

07792
Lerma Engineering Corp
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933
Use 49956
Raytheon Co
Semiconductor Div. HQ
Mountain View, California

08225
Industro Transistor Corp
Long Island City, New York

Federal Supply Codes for Manufacturers (cont)

08261
Spectra Strip Corp
Garden Grove, California

08530
Reliance Mica Corp
Brooklyn, New York

08806
General Electric Co
Miniature Lamp Products Dept
Cleveland, Ohio

08863
Nylomatic Corp
Norristville, Pennsylvania

08988
Use 53085
Skottie Electronics Inc
Archbald, Pennsylvania

09214
G E Co Semi-Conductor
Products Dept
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components Inc
Santa Barbara, California

09922
Burndy Corp
Norwalk Connecticut

09969
Dale Electronics Inc
Yankton, S Dakota

10059
Barker Engineering Corp
Formerly Amerace Amerace
ESNA Corp
Kenilworth, New Jersey

11236
CTS of Berne
Berne Indiana

11237
CTS Keene Inc.
Paso Robles California

11358
CBS Electronic Div
Columbia Broadcasting System
Newburyport, Minnesota

11403
Best Products Co
Chicago, Illinois

11503
Keystone Columbia Inc
Warren Michigan

11532
Teledyne Relays
Hawthorne California

11711
General Instrument Corp
Rectifier Division
Hicksville New York

11726
Quality dyne Corp
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12040
National Semiconductor Corp
Danburry, Connecticut

12060
Diodes Inc
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12300
Potter-Brumfield Div
AMF Canada LTD
Guelph, Ontario, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp formerly
Freeway Washer & Stamping Co.
Cleveland Ohio

12443
The Budd Co. Polychem Products
Plastic Products Div
Bridgeport, Pennsylvania

12615
U S Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc
Lake Mills Wisconsin

12697
Clarostat Mfg Co
Dover New Hampshire

12749
James Electronics
Chicago, Illinois

12856
Micrometals
Sierra Madre, California

12954
Dickson Electronics Corp
Scottsdale Arizona

12969
Unitrode Corp
Watertown Massachusetts

13103
Thermalloy Co., Inc
Dallas Texas

13327
Solitron Devices Inc
Tappan New York

13511
Amphenol Cadre Div
Bunker-Ramo Corp
Los Gatos California

13606
Use 56289
Sprague Electric Co.
Transistor Div
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp
Newbury Park, California

14140
Edison Electronic Div
Mc Gray-Edison Co.
Manchester, New Hampshire

14193
Cal-R-Inc, formerly
California Resistor, Corp
Santa Monica, California

14298
American Components, Inc.
an Insilco Co.
Conshohocken, Pennsylvania

14655
Cornell-Dublier Electronics
Division of Federal Pacific
Electric Co Govt. Control Dept.
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Trol Inc
Saugus, California

15801
Fenwal Electronics Inc
Div of Kidde Walter and Co., Inc
Framingham, Massachusetts

15818
Teledyne Semiconductors
formerly Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc
Van Nuys, California

15898
International Business
Machines Corp
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc
Burbank, California

16299
Corning Glass
Electronic Components Div
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Div. of Chemed Corporation
Cambridge, Maryland

16742
Paramount Plastics
Fabricators, Inc.
Downey, California

16758
Delco Electronics
Div. of General Motors Corp.
Kokomo, Indiana

17001
Replaced by 71468

17069
Circuit Structures Lab
Burbank, California

17338
High Pressure Eng. Co., Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc
Maryland Heights, Missouri

18324
Signetics Corp
Sunnyvale, California

18612
Vishay Resistor Products Div.
Vishay Intertechnology Inc.
Malvern Pennsylvania

18736
Voltronics Corp
Hanover, New Jersey

18927
GTE Sylvania Inc
Precision Material Group
Parts Division
Titusville, Pennsylvania

19451
Perine Machinery & Supply Co
Seattle Washington

19701
Electro-Midland Corp
Mepco-Electra Inc
Mineral Wells, Texas

20564
Enochs Mfg Inc
Indianapolis, Indiana

Federal Supply Codes for Manufacturers (cont)

20891
Self-Organizing Systems, Inc.
Dallas Texas

21604
Bucheye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc
Transistor Division
Riviera Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp Corp
Mount Vernon, New York

23732
Tracor Inc
Rockville, Maryland

23880
Stanford Applied Engrng
Santa Clara California

23936
Pamotor Div , Wm J Purdy Co
Burlingame, California

24248
Replaced by 94222

24355
Analog Devices Inc
Norwood Massachusetts

24655
General Radio
Concord Massachusetts

24759
Lenox-Fugle Electronics Inc
South Plainfield, New Jersey

25088
Siemen Corp
Isilen, New Jersey

25403
Amperex Electronic Corp
Semiconductor &
Micro-Circuits Div
Slatersville, Rhode Island

27014
National Semiconductor Corp.
Santa Clara, California

27264
Molex Products
Downers Grove Illinois

28213
Minnesota Mining & Mfg Co
Consumer Products Div
St Paul, Minnesota

28425
Serv-o-Link formerly
Bohannan Industries
Fort Worth, Texas

28478
Deitrol Controls Div
Deitrol Corporation
Milwaukee, Wisconsin

28480
Hewlett Packard Co.
Corporate HQ
Palo Alto California

28520
Heyman Mfg Co.
Kenilworth, New Jersey

29083
Monsanto, Co , Inc
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30148
AB Enterprise Inc.
Ahoskie, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

31091
Optimax Inc.
Colmar, Pennsylvania

32539
Mura Corp
Great Neck, New York

32767
Griffith Plastic Corp
Burlingame, California

32879
Advanced Mechanical
Components
Northridge, California

32897
Erie Technological Products, Inc.
Frequency Control Div
Carlisle Pennsylvania

32997
Bourns Inc.
Trimpot Products Division
Riverside, California

33173
General Electric Co.
Products Dept
Owensboro, Kentucky

34333
Silicon General
Westminster, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc
Kenilworth, New Jersey

37942
P R Mallory & Co , Inc.
Indianapolis Indiana

42498
National Radio
Melrose Massachusetts

43543
Nytronics Inc.
Transformer Co Div.
Geneva New York

44655
Ohmite Mfg Co.
Skokie, Illinois

49671
RCA Corp
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

54294
Cutler-Hammer Inc. formerly
Shallcross, A Cutler-Hammer Co.
Selma, North Carolina

55026
Simpson Electric Co
Div of Am Gage and Mach. Co.
Elgin, Illinois

56289
Sprague Electric Co
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

60399
Torin Corp formerly
Torrington Mfg Co
Torrington, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

64834
West Mfg Co
San Francisco California

65092
Weston Instruments Inc
Newark, New Jersey

66150
Winslow Tele-Tronics Inc
Eaton Town, New Jersey

70485
Atlantic India Rubber Works
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71002
Birnback Radio Co., Inc.
Freeport, New York

71400
Bussmann Mfg
Div of McGraw-Edison Co.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare C.P & Co
Chicago, Illinois

71590
Centralab Electronics
Div of Globe Union Inc.
Milwaukee, Wisconsin

71707
Coto Coil Co , Inc
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Cinch Connector Operations Div.
Elk Grove Village
Chicago, Illinois

72005
Wilber B Driver Co.
Newark, New Jersey

72092
Replaced by 06980

72136
Electro Motive Mfg. Co
Willamantic, Connecticut

72259
Nytronics Inc
Pelham Manor, New Jersey

72619
Dialight Div
Amperex Electronic Corp
Brooklyn, New York

72653
G C Electronics
Div of Hydrometals, Inc
Brooklyn, New York

72665
Replaced by 90303

72794
Dzus Fastener Co , Inc
West Islip New York

72928
Gulton Ind Inc
Gudeman Div
Chicago, Illinois

Federal Supply Codes for Manufacturers (cont)

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Beckman Instrument Inc.
Helipot Division
Fullerton, California

73293
Hughes Aircraft Co
Electron Dynamics Div
Torrance, California

73445
Amperex Electronic Corp
Hicksville, New York

73559
Carling Electric Inc
West Hartford, Connecticut

73586
Circle F Industries
Trenton, New Jersey

73734
Federal Screw Products, Inc
Chicago, Illinois

73743
Fischer Special Mfg. Co
Cincinnati, Ohio

73899
JFD Electronics Co
Components Corp
Brooklyn, New York

73949
Guardian Electric Mfg. Co
Chicago, Illinois

74199
Quan-Nichols Co
Chicago, Illinois

74217
Radio Switch Corp
Manboro, New Jersey

74276
Signalite Div
General Instrument Corp
Neptune, New Jersey

74306
Piezo Crystal Co
Carlisle, Pennsylvania

74542
Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970
Johnson E.F. Co
Waseca, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75376
Kurz-Kasch Inc
Dayton, Ohio

75378
CTS Knights Inc
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

76854
Oak Industries Inc.
Switch Div
Crystal Lake, Illinois

77342
AMF Inc.
Potter & Brumfield Div
Princeton, Indiana

77638
General Instrument Corp
Rectifier Division
Brooklyn, New York

77969
Rubbercraft Corp. of CA. LTD
Torrance, California

78189
Shakeproof
Div. of Illinois Tool Works Inc.
Elgin, Illinois

78277
Sigma Instruments, Inc.
South Braintree, Massachusetts

78488
Stackpole Carbon Co
Saint Marys, Pennsylvania

78553
Eaton Corp. Engineered
Fastener Div
Tinnerman Plant
Cleveland, Ohio

79136
Waldes Kohinoor Inc
Long Island City, New York

79497
Western Rubber Company
Goshen, Indiana

79963
Zierick Mfg. Corp
Mt. Kisko, New York

80031
Electro-Midland Corp
Mepco Div
A North American Phillips Co
Norristown, New Jersey

80145
LFE Corp., Process Control Div
formerly API Instrument Co
Chesterland, Ohio

80183
Use 56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div
Riverside, California

80583
Hammarlund Mfg. Co., Inc.
Red Bank, New Jersey

80640
Arnold Stevens, Inc.
South Boston, Massachusetts

81073
Grayhill, Inc.
La Grange, Illinois

81312
Winchester Electronics
Div. of Litton Industries Inc.
Oakville, Connecticut

81483
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp
Los Angeles, California

81590
Korry Mfg. Co
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82305
Palmer Electronics Corp
South Gate, California

82389
Switchcraft Inc.
Chicago, Illinois

82415
North American Phillips
Controls Corp
Frederick, Maryland

82872
Roanwell Corp
New York, New York

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div
Pawtucket, Rhode Island

83003
Varo Inc
Garland, Texas

83058
The Carr Co., United Can Div
of TRW
Cambridge, Massachusetts

83298
Bendix Corp
Electric Power Div
Eatontown, New Jersey

83330
Herman H. Smith, Inc.
Brooklyn, New York

83478
Rubbercraft Corp
of America, Inc
West Haven, Connecticut

83594
Burroughs Corp
Electronic Components Div.
Plainfield, New Jersey

83740
Union Carbide Corp
Battery Products Div
formerly Consumer Products Div.
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
TRW Capacitors
Ogallala, Nebraska

84613
Fuse Indicator Corp
Rockville, Maryland

84682
Essex International Inc.
Industrial Wire Div.
Peabody, Massachusetts

86577
Precision Metal Products
of Malden Inc.
Stoneham, Massachusetts

86684
Radio Corp. of America
Electronic Components Div.
Harrison, New Jersey

86928
Seastrom Mfg. Co., Inc
Glendale, California

87034
Illuminated Products Inc.
Subsidiary of Oak Industries Inc
Anaheim, California

88219
Gould Inc
Industrial Div
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div
Van Nuys, California

88419
Cornell-Dubilier Electronic Div
Federal Pacific Co
Fuquay-Varian, North Carolina

88486
Plastic Wire & Cable
Jewitt City, Connecticut

88690
Replaced by 04217

89536
John Fluke Mfg. Co., Inc
Seattle, Washington

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

Federal Supply Codes for Manufacturers (cont)

90201
Mallory Capacitor Co.
Div. of P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211
Use 56365
Square D Co.
Chicago, Illinois

90215
Best Stamp & Mfg. Co
Kansas City, Missouri

90303
Mallory Battery Co.
Div. of Mallory Co., Inc
Tarrytown, New York

91094
Essex International Inc.
Suglex/IWP Div
Newmarket, New Hampshire

91293
Johanson Mfg. Co
Boonton, New Jersey

91407
Replaced by 58474

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc
Columbus, Nebraska

91662
Elco Corp
Willow Grove, Pennsylvania

91737
Use 71468
Gremar Mfg. Co., Inc.
ITT Cannon-Gremar
Santa Ana, California

91802
Industrial Devices, Inc
Edgewater, New Jersey

91833
Keystone Electronics Corp
New York, New York

91836
King's Electronics Co., Inc.
Tuckahoe, New York

91929
Honeywell Inc
Micro Switch Div
Freeport, Illinois

91934
Miller Electric Co., Inc.
Div. of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div
Woburn, Massachusetts

94145
Replaced by 49956

94154
Use 94988
Wagner Electric Corp
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp
Lester, Pennsylvania

95146
Alco Electronic Products Inc
Lawrence, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95264
Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp
Receiving Tube Div
Cincinnati, Ohio

95348
Gordo's Corp
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
Rolling Meadows, Illinois

95712
Bendix Corp
Electrical Components Div.
Microwave Devices Plant
Franklin, Indiana

95987
Weckesser Co. Inc
Chicago, Illinois

96733
San Fernando Electric Mfg. Co
San Fernando, California

96853
Gulton Industries Inc.
Measurement and Controls Div
formerly Rustrak Instruments Co
Manchester, New Hampshire

96881
Thomson Industries, Inc.
Manhasset, New York

97540
Master Mobile Mounts Div. of
Whitehall Electronics Corp.
Ft. Meyers, Florida

97913
Industrial Electronic
Hardware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdot Co., Inc.
Connector & Cable Div
Pasadena, California

98291
Sealectro Corp
Mamaroneck, New York

98388
Royal Industries
Products Div
San Diego, California

98743
Replaced by 12749

98925
Replaced by 14433

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect.
Comp. Div.
formerly Southern Elect. Div.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Div. of ITT Jennings formerly
Marshall Industries Capacitor Div.
Monrovia, California

99779
Use 29587
Bunker-Ramo Corp.
Barnes Div
Landsdowne, Pennsylvania

99800
American Precision Industries Inc
Delevan Division
East Aurora, New York

99942
Centrelab Semiconductor
Centrelab Electronics Div. of
Globe-Union Inc
El Monte, California

Toyo Electronics
(R-Ohm Corp.)
Irvine, California

National Connector
Minneapolis, Minnesota

Section 8
Schematic Diagrams

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WORLD-WIDE SERVICE ORGANIZATION

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Rolling Meadows, IL 60008
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Burbank, CA 91504
(213) 849-4561

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P.O. Box 330
Paramus, NJ 07652
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3740 Industrial Ave
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Dallas, TX 75240
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Fluke Technical Center
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604 294-1529

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TLX: 790258?

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Elmeasco Instruments Pty Ltd.
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Australia
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Sistemas E Instrumentacion, Ltda.
Carrera 13 No. 37-43 Of. 401
Ap. Aereo: 29583
Bogota, DE, Colombia SA
Tel: 232-4532
TLX: 45787 COASN CO

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Edificio Jericho
Ave. 12 de octubre 42253 y
Ave. Orellana, Planta Baja
Quito, Ecuador
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TLX: 2865 Protec Ed
Cable: PROTECO

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TLX: 0845*41

Hinditron Services Pvt. Ltd.
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TLX: 031 4690 SPAR IN

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Tel: 261-2702, 260-1868
TLX: K25387

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West Malaysia
Tel: 58000
TLX: OCONN MA 37549
Cable: OCONNOR PETALING JAYA

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Uxmal No. 30
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Tel: 530-72-24 y 44
TLX: 1773

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TLX: NZ21570 THERMAL

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TLX: 24494 PIO PK

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Lima 1, Peru
Tel: 288450
TLX: 3742/563

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Metro Manila, Philippines 3113
Tel: 78-78-16
TLX: 27801 RCA PH

Rank O'Conner's (PTE) Limited
98 Fast Paharang Road
Singapore 2555
Harbour of Singapore
Tel: 637844, 239052
TLX: OCONSIN RS21023

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Taipei, Taiwan
Tel: 5414816
TLX: 11111 Schmidt

Measuretronix Ltd.
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Huamark, Bangkok 24
Thailand
Tel: 3143369, 3143430
TLX: 81143 OEC/EXAK TH

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Correo Central
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Los Ruices
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